



**JECRC<sup>TM</sup>**  
**UNIVERSITY**  
BUILD YOUR WORLD

**School of Sciences**  
**Course Structure and Syllabus**  
**B. Sc. Microbiology**  
**Academic Programme**  
**2021-2024**

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**Programme Outcome:** After completion of degree course the student will be acquainted with sufficient knowledge in Microbiology. The degree program combines the teaching of core principles with hands-on laboratory experience, preparing students for exciting careers in industry and academia.

The course also provides a wide range of opportunities in *industries, pharmaceutical companies, Health care services* and *teaching* after graduating the course.

**The student outcomes are:**

1. To familiarize students with fundamental concept of basic techniques and their applications in applied sciences.
2. It is expected that the knowledge gained through this course will make student competent to meet the challenges of academic and professional courses.
3. To train the student in various aspects related to applied microbiology and medical microbiology.
4. An ability to apply profound understanding of basic to applied microbiology.
4. An ability to design and perform experiments, as well as to analyze and interpret data.
5. An ability to communicate effectively with reference to speaking, reading, writing and listening clearly in person through electronic media in English and Hindi and able to get acquainted with the people, ideas books media and technology.
6. A recognition of the need for, and an ability to engage in life-long learning.
7. A knowledge of contemporary and burning issues.

#### **B.Sc. Microbiology Program Educational Objective (PEO's):**

A Graduate of the Microbiology should:

##### **PEO-I**

Students will develop themselves as effective professionals by the knowledge gained with attention to team work, effective communication, critical thinking and problem solving skills.

##### **PEO-II**

Students will develop professional skills that prepare them for self employment as well as to qualify competitive examination and life-long learning in advanced areas of Microbiology and applied fields.

##### **PEO-III**

Students will demonstrate their ability to adapt to a rapidly changing environment by having learned and applied new skills and new technologies.

##### **PEO-IV**

Students will be provided with an educational foundation that prepares them for excellence, leadership roles along diverse career paths with encouragement to professional ethics and active participation needed for a successful career.

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The bottom of the page features several handwritten signatures in blue ink. From left to right, there is a large signature, a signature with the number '2' above it, a signature that appears to be 'Rashmi', and another signature. Below the 'Rashmi' signature, the name 'Rashmi' is written in a larger, more legible script.

### Program Outcome

A candidate who is conferred an UG (Hons) degree i.e. B.Sc. (Hons) degree in microbiology needs to have acquired/developed following competencies during the programme of the study:

PO1. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others

PO2. Demonstrate key practical skills/competencies in working with microbes for study and use in the laboratory as well as outside, including the use of good microbiological practices.

PO3. Competent enough to use microbiology knowledge and skills to analyze problems involving microbes, articulate these with peers/ team members/ other stake holders, and undertake remedial measures/ studies etc.

PO4. Developed a broader perspective of the discipline of Microbiology to enable him/her to identify challenging societal problems and plan his professional career to develop innovative solutions for such problems.

PO5. Acknowledges health safety environment (HSE) and ethical issues in handling chemicals and biological materials; understands the environmental impacts associated with the activity; performs risk assessments and is familiar with safety instructions in his/her subject area.

PO6. Can communicate scientific results to the general public and experts by writing well structured reports and— contributions for scientific publications and by oral presentations

PO7. To demonstrate knowledge to understand the culture, essential facts, concepts, principles and theories relating to the subject areas identified and to recognize, analyze problems and plan strategies for their solution.

**JECRC UNIVERSITY**  
**FACULTY OF SCIENCE**  
**SESSION 2021-2022**

Details of Scheme for B Sc.(Hons.) with various Courses & their credits with contact Hours

**\*\*Note:** In 6th Semester Students have a Choice either he can go for offered Courses or he may avail Internship in some reputed Institute / Industry or In House Dissertation

**Semester I**

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
BMI001C	Physicochemical Techniques	4	-	2	4		1	5	Core
BMI003C	Microbial Diversity	4	-	2	4		1	5	Core
BMI070A	Cell and Molecular Biology	4	-	2	4		1	5	Core
DCA001A	Web Development	2	0	2	1	0	2	3	Fundamental
DEN001A	Communication Skills	2	0	2	2	0	1	3	Foundation
DIN001A	Culture Education - 1	2	0	0	2	0	0	2	Foundation
DCH001A	Environment Studies	3		2*	3	0	1	4	Fundamental
		21		12	21		6	27	

**Semester II**

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
BMI072A	Bacteriology and Systematics	4	-	2	4		1	5	Core
BMI005C	Biochemistry	4	-	2	4		1	5	Core
BMI074A	Mycology and Phycology	4	-	2	4		1	5	Core
	Discipline Specific Elective - I	4	-	2	4		1	5	Discipline Specific Elective-1
DCA003A	Project Management Lab	0	0	2	0	0	1	1	Fundamental
DEN002A	Professional Skills	2	0	2	2	0	1	3	Foundation
DIN002A	Culture Education - 2	2	0	0	2	0	0	2	Foundation
		20		12	20		6	26	

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### Semester III

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
BM1017C	Virology	4	-	2	4		1	5	Core
BM1029C	Microbial Physiology	4	-	2	4		1	5	Core
	Discipline Specific Elective - II	4	-	2	4		1	5	Discipline Specific Elective-2
DCA004A	Advanced Spread Sheet Lab	0	0	2	0	0	1	1	Fundamental
DEN003A	Life Skills - 1 (Personality Development)	1	0	2	1	0	1	2	Foundation
DIN003A	Value Education and Ethics -1	1	0	0	1	0	0	1	Foundation
	Open Elective-I	3	0	0	3	0	0	3	Interdisciplinary
	Open Elective-II	3	0	0	3	0	0	3	Interdisciplinary
		20		10	20		5	25	

### Semester IV

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
BM1022C	Microbial Genetics	4	-	2	4		1	5	Core
	Discipline Specific Elective - III	4	-	2	4		1	5	Discipline Specific Elective - 3
	Discipline Specific Elective - IV	4	-	2	4		1	5	Discipline Specific Elective-4
DCA005A	Python programming	2	0	2	2	0	1	3	Fundamental
DEN 004A	Life Skills - 2 (Aptitude)	1	0	2	1	0	1	2	Foundation
DIN 004A	Value Education and Ethics - 2	1	0	0	1	0	0	1	Foundation
	Research Methodology	3	1	0	3	1	0	4	Interdisciplinary
								25	

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### Semester V

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
BMI024B	Biostatistics	4	-	2	4		1	5	Core
BMI076A	Genetic Engineering	4	-	2	4		1	5	Core
	Discipline Specific Elective-V	4		2	4		1	5	Discipline Specific Elective- 5
BMI047A	Project work on Microbiology of Societal Importance							6	Discipline Specific Elective- 6
	Open Elective III	3	-	-	3			3	Interdisciplinary
								24	

Semester VI: \*\*Note: In 6th Semester Student have a Choice either he can go for offered Courses or he may avail Internship in some reputed Institute / Industry or In House Dissertation

Subject Code	Subject	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
					L	T	P		
BMI078A	Agriculture and Veterinary Microbiology	4	-	2	4		1	5	Core
BMI080A	Advance Microbiology	4	-	2	4		1	5	Core
	Discipline Specific Elective-VII	4	-	2	4		1	5	Discipline Specific Elective- 7
	Open Elective- IV	3	-	0	3		0	3	Interdisciplinary



	Open Elective-V	3		0	3		0	3	Interdisciplinary
		18		6	18		3	21	

Total Credits

Credits	I Sem	II Sem	III Sem	IV Sem	V Sem	VI Sem	Total
	27	26	25	25	24	21	148

MIT courses

1	Cell Biology	MIT	<a href="https://ocw.mit.edu/courses/biology/7-06-cell-biology-spring-2007/">https://ocw.mit.edu/courses/biology/7-06-cell-biology-spring-2007/</a>
2	Biological Chemistry I	MIT	<a href="https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/index.htm?utm_source=OCWCourseList&amp;utm_medium=CarouselSm&amp;utm_campaign=Feat">https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/index.htm?utm_source=OCWCourseList&amp;utm_medium=CarouselSm&amp;utm_campaign=Feat</a>
3	Fundamentals of Biology	MIT	<a href="https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/index.htm?utm_source=OCWHomePage&amp;utm_medium=CarouselSm&amp;utm_campaign=FeaturedCourse">https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/index.htm?utm_source=OCWHomePage&amp;utm_medium=CarouselSm&amp;utm_campaign=FeaturedCourse</a>





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# B. Sc. Microbiology Department Course

## Semester –I

Course	Title	L	P	C
BMI001C	Physicochemical Techniques	4		4
BMI002C	Physicochemical Techniques Lab		1	1
BMI 003C	Microbial Diversity	4		4
BMI 004C	Microbial Diversity Lab		1	1
BMI070A	Cell and Molecular Biology	4		4
BMI071A	Cell and Molecular Biology Lab		1	1

## Semester –II

BMI072A	Bacteriology and Systematics	4		4
BMI073A	Bacteriology and Systematics Lab		1	1
BMI005C	Biochemistry	4		4
BMI006C	Biochemistry Lab		1	1
BMI074A	Mycology and Phycology	4		4
BMI075A	Mycology and Phycology Lab		1	1
	Discipline Specific Elective –I	4		4
	Discipline Specific Elective -I Lab		1	1

## Semester –III

BMI017C	Virology	4		4
BMI018C	Virology		1	1
BMI029C	Microbial Physiology	4		4
BMI030C	Microbial Physiology Lab		1	1
	Discipline Specific Elective –II	4		4
	Discipline Specific Elective -II Lab		1	1








**Semester –IV**

BMI022C	Microbial Genetics	4		4
BMI023C	Microbial Genetics Lab		1	1
	Discipline Specific Elective – III	4		4
	Discipline Specific Elective – III Lab		1	1
	Discipline Specific Elective –IV	4		4
	Discipline Specific Elective -IV Lab		1	1

**Semester –V**

BMI024B	Biostatistics	4		4
BMI025B	Biostatistics Lab		1	1
BMI076A	Genetic Engineering	4		4
BMI077A	Genetic Engineering Lab		1	1
BMI047A	Project			6
	Discipline Specific Elective –V	4		4
	Discipline Specific Elective -V Lab		1	1

**Semester –VI**

BMI078A	Agriculture and Veterinary Microbiology	4		4
BMI079A	Agriculture and Veterinary Microbiology Lab		1	1
BMI080A	Advance Microbiology	4		4
BMI081A	Advance Microbiology Lab		1	1
	Discipline Specific Elective-VII	4		4
	Discipline Specific Elective-VII Lab		1	1


  
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### Discipline Specific Elective Papers

Tracks	Course Code	Title	L	P	C
Food Microbiology	BMI082A	Fundamentals of Food Microbiology	4		4
	BMI083A	Fundamentals of Food Microbiology Lab		1	1
	BMI084A	Food Chemistry	4		4
	BMI085A	Food Chemistry Lab		1	1
	BMI086A	Food Packaging Technology	4		4
	BMI087A	Food Packaging Technology Lab		1	1
	BMI088A	Food Quality and Foodborne Diseases	4		4
	BMI089A	Food Quality and Foodborne Diseases Lab		1	1
	BMI090A	Dairy Microbiology	4		4
	BMI091A	Dairy Microbiology Lab		1	1
	BMI092A	Food Law and Standards	4		4
	BMI093A	Food Law and Standards Lab		1	1
	BMI094A	Microbial toxins and food protection	4		4
	BMI095A	Microbial toxins and food protection Lab		1	1
Medical Microbiology	BMI096A	Introduction of Medical Microbiology	4		4
	BMI097A	Introduction of Medical Microbiology Lab		1	1
	BMI101B	Immunology	4		4
	BMI1011B	Immunology Lab		1	1
	BMI098A	General Pathology	4		4
	BMI099A	General Pathology Lab		1	1
	BMI100A	Clinical Biochemistry	4		4
	BMI101A	Clinical Biochemistry Lab		1	1
	BMI102A	Automation in Medical Microbiology	4		4
	BMI103A	Automation in Medical Microbiology Lab		1	1
	BMI104A	Human Anatomy and Physiology	4		4
	BMI105A	Human Anatomy and Physiology Lab		1	1






	BMI106A	Parasitology			
	BMI107A	Parasitology Lab			
Industrial Microbiology	BMI108A	Basic Industrial Microbiology	4		4
	BMI109A	Basic Industrial Microbiology Lab		1	1
	BMI110A	Fermentation Technology	4		4
	BMI111A	Fermentation Technology Lab		1	1
	BMI112A	Microbial Productions of Metabolites	4		4
	BMI113A	Microbial Productions of Metabolites Lab		1	1
	BMI114A	Quality Assurance and Quality Control of Microbial Products	4		4
	BMI115A	Quality Assurance and Quality Control of Microbial Products Lab		1	1
	BMI116A	Industrial Management, Government Laws and Regulations	4		4
	BMI117A	Industrial Management, Government Laws and Regulations Lab		1	1
	BMI118A	Biomining and Microbial Metabolites	4		4
	BMI119A	Biomining and Microbial Metabolites Lab		1	1
	BMI120A	Microbial Products for Human Consumption	4		4
	BMI121A	Microbial Products for Human Consumption Lab		1	1
Environment Microbiology	BMI122A	Environment and Microorganism	4		4
	BMI123A	Environment and Microorganism Lab		1	1
	BMI124A	Eco Restoration and Development	4		4
	BMI125A	Eco Restoration and Development Lab		1	1
	BMI126A	Environmental Monitoring	4		4
	BMI127A	Environmental Monitoring Lab		1	1
	BMI048A	Waste Management	4		4
	BMI049A	Waste Management Lab		1	1
	BMI128A	Environmental Legislation and Policy	4		4

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BMI129A	Environmental Legislation and Policy Lab		1	1
BMI130A	Microbial Ecology	4		4
BMI131A	Microbial Ecology Lab		1	1
BMI132A	Agro-Environment Microbiology	4		4
BMI133A	Agro-Environment Microbiology Lab		1	1

### Open electives offer by Department

Open Elective-I Human Microbial Disease Management (BMI134A)

Open Elective-II Microbial Products (BMI135A)

Open Elective-III Biosafety and IPR (BMI136A)

### Virtual Labs

S.No	Course Name	Sources	Link
1	Biochemistry Virtual Lab I	AMRITA VISHWA VIDYAPEETHAM	<a href="http://biotech01.vlabs.ac.in/">http://biotech01.vlabs.ac.in/</a>
2	Biochemistry Virtual Lab II	AMRITA VISHWA VIDYAPEETHAM	<a href="https://vlab.amrita.edu/?sub=3&amp;brch=64">https://vlab.amrita.edu/?sub=3&amp;brch=64</a>
3	Immunology Virtual Lab I	AMRITA VISHWA VIDYAPEETHAM	<a href="https://vlab.amrita.edu/?sub=3&amp;brch=69">https://vlab.amrita.edu/?sub=3&amp;brch=69</a>
4	Immunology Virtual Lab II	AMRITA VISHWA VIDYAPEETHAM	<a href="https://vlab.amrita.edu/?sub=3&amp;brch=70">https://vlab.amrita.edu/?sub=3&amp;brch=70</a>
5	Microbiology Virtual Lab I	AMRITA VISHWA VIDYAPEETHAM	<a href="https://mvi-au.vlabs.ac.in/">https://mvi-au.vlabs.ac.in/</a>
6	Microbiology Virtual Lab II	AMRITA VISHWA VIDYAPEETHAM	<a href="https://vlab.amrita.edu/?sub=3&amp;brch=76">https://vlab.amrita.edu/?sub=3&amp;brch=76</a>
7	Molecular Biology Virtual Lab I	AMRITA VISHWA VIDYAPEETHAM	<a href="http://mbvi-au.vlabs.ac.in/">http://mbvi-au.vlabs.ac.in/</a>
8	Molecular Biology Virtual Lab II	AMRITA VISHWA VIDYAPEETHAM	<a href="https://mbvii-au.vlabs.ac.in/">https://mbvii-au.vlabs.ac.in/</a>
9	Cell Biology Virtual Lab I	AMRITA VISHWA VIDYAPEETHAM	<a href="http://cbi-au.vlabs.ac.in/">http://cbi-au.vlabs.ac.in/</a>
10	Cell Biology Virtual Lab II	AMRITA VISHWA VIDYAPEETHAM	<a href="http://cbii-au.vlabs.ac.in/">http://cbii-au.vlabs.ac.in/</a>
11	Bioinformatics Virtual Lab II	AMRITA VISHWA VIDYAPEETHAM	<a href="https://vlab.amrita.edu/index.php?sub=3&amp;brc h=274">https://vlab.amrita.edu/index.php?sub=3&amp;brc h=274</a>
12	Ecology Virtual Lab	AMRITA VISHWA VIDYAPEETHAM	<a href="https://vlab.amrita.edu/index.php?sub=3&amp;brc h=274">https://vlab.amrita.edu/index.php?sub=3&amp;brc h=274</a>

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13	Bioreactor Modeling and Simulation Lab	IIT Delhi	<a href="http://38.100.110.143/model/index.html">http://38.100.110.143/model/index.html</a>
14	Biological image analysis virtual Lab I	AMRITA VISHWA VIDYAPEETHAM	<a href="https://vlab.amrita.edu/?sub=3&amp;brch=278">https://vlab.amrita.edu/?sub=3&amp;brch=278</a>

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI001C	Physicochemical Techniques	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

- CO1-Understand the general principle, working and applications of laboratory instruments.  
CO2-Understand the basic principle, working and applications of centrifugation and electrophoresis technique.  
CO3-Understand the basic of autoradiography, biological hazards of radiation and safety measures in handling radioisotopes  
CO4- Understand the Microbial techniques used in microbial lab and cultivation of microbes in lab.  
CO5-Understand the culture techniques and general staining techniques used for bacteria, fungi and algae.

#### Unit-I

General lab Instruments: principle, working and applications of pH meter, Autoclave, laminar air flow, calorimeter, spectrophotometer, centrifuge, water bath, vortex mixer, oven, incubator and colony counter. Microscopy: light microscopy, phase contrast, Fluorescence microscopy and electron microscopy.

#### Unit -II

Centrifugation: types, working, principle and applications; Electrophoresis: types, working, principle and applications.

#### Unit – III

Radioisotopic Techniques: Types of radioisotopes used in Biochemistry, units of radioactivity measurements, isotopes commonly used in biochemical studies –  $^{32}\text{P}$ ,  $^{35}\text{S}$ ,  $^{14}\text{C}$  and  $^3\text{H}$ ).

#### Unit IV

Chromatography: types, working, principle and applications; Spectroscopic Techniques: Beer-Lambert law, light absorption and its transmittance, application of visible and UV spectroscopic techniques

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## Unit V

Autoradiography. Biological hazards of radiation and safety measures in handling radioisotopes. Biological applications of radioisotopes.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	3	2	1	1	1
CO2	2	3	3	3	3	3	3
CO3	1	1	2	3	2	2	0
CO4	3	2	3	1	1	0	0
CO5	3	3	2	0	3	0	1

3 = Highly Related; 2 = Medium; 1 = Low

### Suggested Readings:

1. Khandelwal P.P., Textbook of optics and atomic physics, 2015, Himalaya Publishing House
2. Patel S.B., Nuclear physics an introduction, 2<sup>nd</sup> edition, 2011, New Age International
3. Pattabhi and Gautha, Biophysics, 2<sup>nd</sup> edition, 2009, Narosa Publishing House
4. Nakara and Choudhary, Instrumentation measurements and analysis, 3<sup>rd</sup> Edition, 2010, Tata Mc Graw Hill
5. Khandpur R.S., Handbook of analytical instruments, 3<sup>rd</sup> Edition, 2015, Tata Mc Graw Hill
6. Beiser A, Perspectives of modern physics, 1969, Mc Graw Hill
7. White H.E., Introduction to atomic spectra, 2005, Mc Graw Hill
8. Lodish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnell, Molecular cell biology, 8<sup>th</sup> edition 2016, W.H. Freeman and Co.

### Physicochemical Techniques Lab (BMI002C)

- 1) Demonstration of laboratory rules, basic requirements in a microbiological laboratory and safety measures.
- 2) Demonstration of the components, use and care of bright field microscope.
- 3) Determination of size of a given microorganism using micrometry.
- 4) Demonstration of the pH meter and determination of pH of a given sample.
- 5) Demonstration of centrifuge and separation of serum and cells from blood sample.
- 6) Demonstration of electrophoresis/ PAGE.
- 7) Separation of chlorophyll a and b using paper chromatography.
- 8) Separation of amino acids using TLC.
- 9) Verification of Beer – Lamberts' Law.
- 10) Demonstration of colorimeter.
- 11) Preparation of standard curve of proteins by spectroscopy.

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Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BM1003C	Microbial Diversity	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the history of microbiology and classification of microorganism.

CO2- Analyze the structural organization of bacterial system.

CO3- Understand the cellular structure, biosynthesis and function of bacterial system.

CO4- Evaluate the structures of algae, fungi and protozoan.

CO5- Apply the sterilization, isolation and staining techniques to the microbial culture.

### Unit-I

History of Microbiology – Overview, Biogenesis and abiogenesis, golden age of microbiology and development in the field of medical microbiology, immunology, environmental microbiology, contributions of Robert Hooke, Antonie von Leeuwenhoek, Redi, Spallanzani, Needham, Pasteur, Tyndal, Joseph Lister, Robert Koch (Germ Theory), Edward Jenner and Alexander Flemming, Martinus Beijerinck, Scope of Microbiology, aim and principles of classification, systematics and taxonomy, conventional, molecular and recent approaches to polyphasic bacterial taxonomy.

### Unit -II

Whittaker's five kingdom classification, Carl Woese three domain classification, Bacterial morphology and subcellular structures; Slime layer, Capsule, Cell wall, cell membrane, Ribosome, inclusion bodies - inorganic, organic; Exospores & Cysts: types & structure. Plasmids and episomes.

### Unit -III

Bacterial Chromosome (Fundamental differences with eukaryotic chromosome). Bacterial cell wall biosynthesis and structure. Differences between eubacteria and archaebacteria.

### Unit -IV

Brief description of salient features, classification of Algae, Fungi and Protozoa: General characteristics, vegetative and reproductive structure of Protozoa: *Giardia*, *Entamoeba* and *Plasmodium*, *Trichomonas*, *monocystes*

### Unit -V

Methods of studying microorganism; Staining techniques: simple staining, Gram staining, negative staining and acid-fast staining. Sterilization techniques (physical & chemical sterilization). Culture media & conditions for microbial growth. Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation of pure cultures.

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**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	0	3	1	3	0
CO2	2	3	1	0	0	1	2
CO3	2	2	1	0	0	1	1
CO4	3	1	3	1	1	2	2
CO5	3	3	2	2	2	2	2

3 = Highly Related; 2 = Medium; 1 = Low

**Suggested Readings:**

1. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR, General Microbiology, 5<sup>th</sup> edition, 2005, McMillan.
2. Atlas, Principles of Microbiology, 2<sup>nd</sup> ed., 1997, McGraw-Hill
3. Alexopoulos CJ, Mims CW, and Blackwell M, Introductory Mycology. 4<sup>th</sup> edition, 1996, John and Sons, Inc.
4. Cappucino J and Sherman N., Microbiology: A Laboratory Manual. 9<sup>th</sup> edition, 2010, Pearson Education limited.
5. Kumar HD., Introductory Phycology, 2<sup>nd</sup> edition, 1990, Affiliated East Western Press.
6. Madigan MT, Martinko JM and Parker J., Brock Biology of Microorganisms. 12<sup>th</sup> edition, 2009, Pearson/Benjamin Cummings.
7. Pelczar MJ, Chan ECS and Krieg NR., Microbiology. 5<sup>th</sup> edition, 1993, McGraw Hill Book Company.
8. Tortora GJ, Funke BR, and Case CL., Microbiology: An Introduction, 9<sup>th</sup> edition, 2008, Pearson Education.

**Microbial Diversity Lab (BMI004C)**

- 1) Preparation of bacterial smear.
- 2) Simple staining of bacteria and fungi.
- 3) Identification of common morphological forms of bacteria.
- 4) Identification of Cyanobacteria (blue-green algae).
- 5) Identification of some common fungi (*Aspergillus*, *Penicillium*, *Mucor* and *Rhizopus*).
- 6) Identification of common algae.
- 7) Demonstration and explanation of different types of viruses.
- 8) Gram staining.
- 9) Microscopic examination of free-living protozoa of a pond.
- 10) Hanging drop technique demonstrating motility of Bacteria.

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Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI070A	Cell and Molecular Biology	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the cell structural organization and function of cell organelles.

CO2- Understand the structure of DNA and its component.

CO3- Understand the cell cycle and its regulation along with extracellular control of cell growth and apoptosis.

CO4- Understand the transcription in prokaryotes and its regulation.

CO5- Understand the concept of split genes, concept of introns and exons and processing of rRNA.

### Unit I

Concepts of cell- Prokaryotic & Eukaryotic cells. Cell organization of Prokaryotic cells with special reference to Bacteria. Eukaryotic cells - cell wall & plasma membrane; structure & function of cell organelles and inclusions. Episome, Mesosome, Flagella and Fimbriae.

### Unit II

Experimental evidences for nucleic acid as genetic material. Structure of DNA; Models of DNA replication. Enzymes, proteins and other factors involved in DNA replication. Mechanism of DNA replication in prokaryotes & eukaryotes Super helicity in DNA, linking number, topological properties.

### Unit III

Cell cycle: Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization. Cell cycle and Programmed cell death- Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth and apoptosis.

### Unit IV

Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit. Transcription in Eukaryotes: RNA polymerases, general Transcription factors. Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote

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## Unit V

Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: siRNA, miRNA and its significance.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	0	1	0	0	1
CO2	1	2	0	1	0	0	1
CO3	3	3	1	0	1	2	0
CO4	2	2	2	0	0	2	1
CO5	2	3	2	0	0	2	1

3 = Highly Related; 2 = Medium; 1 = Low

### Suggested Readings:

1. Karp, G., Cell and Molecular Biology: Concepts and Experiments, 6<sup>th</sup> Edition, 2010. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology, 8<sup>th</sup> Edition, 2006, Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman R.E., The Cell: A Molecular Approach, 5<sup>th</sup> Edition, 2009, ASM Press & Sunderland, Washington, D.C.
4. Becker W.M., Kleinsmith L.J., Hardin. J. and Berton G. P., The World of the Cell, 7<sup>th</sup> Edition, 2009, Pearson Benjamin Cummings Publishing

### Cell and Molecular Biology (BM1071A)

- 1) To analyze prepared slides of mitosis.
- 2) To perform and identify different stages of mitosis in onion root tip.
- 3) To analyze prepared slides of meiosis.
- 4) To perform and identify different stages of meiosis in onion flower bud.
- 5) To prepare the slide of giant chromosome.
- 6) Isolation of genomic and plasmid DNA from *E.coli*
- 7) Estimations of DNA using diphenylamine reagent, and UV spectrophotometer (A260 measurement)
- 8) Estimations of RNA using orcinol reagent, and UV spectrophotometer (A260 measurement)
- 9) Resolution and visualization of DNA by Agarose Gel Electrophoresis.

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Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI072A	Bacteriology and Systematics	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the classification of bacterial bergey's manual and functioning of microbial structure.

CO2- Analyze the various shapes, habitat and function of Gram negative.

CO3- Analyze the archeobacteria structure, habitat and its type.

CO4- Analyze the various shapes, habitat and usefulness of Gram positive.

CO5- Analyze the bacterial growth, control and preservation.

#### Unit I

Bacteria: Internal structure, Bacterial shapes and arrangement, cell membrane, cell wall of bacteria, inclusion bodies, flagella, capsule, slime, fimbriae and pilli. Bacterial endospores – structure, formation and germination, Effect of antibiotics and enzymes on the cell wall and formation of spheroplasts, protoplasts and L-forms. A brief outline of salient features of major bacterial groups according to Bergey's manual of systematic Bacteriology Volume I and II.

#### Unit II

Gram negative Eubacteria: The Spirochetes, Aerobic/microaerophilic, motile, helical/vibroid, Gram negative Bacteria, Non motile, Gram negative curved bacteria. Aerobic, anaerobic and facultative anaerobic bacteria.

#### Unit III

Sulphur reducing bacteria. Anaerobic Gram negative Cocci. *Neisseria*, *Rickettsia*, *Chlamydia*, Anaerobic Gram negative rods: *Rhizobium*, *Agrobacterium*, *Salmonella*, Archaeobacteria: Introduction to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*).

#### Unit IV

Gram positive Eubacteria: Gram positive Cocci; *Streptococcus*, *staphylococcus*, Gram Positive rod; *Bacillus*, *Clostridium*, endospore forming Gram positive bacteria, Non-spore forming Gram positive Rods of regular shape, Nons pore forming Gram positive Rods of irregular shape; *Corynebacterium*

#### Unit V

Cultivation of Bacteria: growth of bacteria, growth curve, environmental factors affecting growth, quorum sensing. Nutritional requirements in bacteria and nutritional categories. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, enriched and enrichment media. Physical methods of microbial

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control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: disinfectants, types and mode of action. Asexual methods of reproduction. Preservation techniques of microbial culture.

#### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	3	0	0	1
CO2	3	3	2	2	2	0	1
CO3	3	3	1	3	2	1	0
CO4	3	2	2	3	2	1	0
CO5	3	2	1	1	0	0	1

3 = Highly Related; 2 = Medium; 1 = Low

#### Suggested Readings:

1. Schlegel H S, General Microbiology, 7th edition, 1995, Cambridge University Press
2. Pelczar M J, Chan E C S, Kreig N R, Microbiology, 5th edition, 2006, Tata Mc Graw Publication
3. Cappuccino J G and Sherman N, Microbiology-a Laboratory Manual, 6th edition, 2006, Addison Wesley, Pearson Education, Inc.
4. Tortora G J, Funke B R, Case C L, Microbiology-an introduction, 9th edition, 2008, Pearson Education, Inc.,
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR, General Microbiology. 5<sup>th</sup> edition, 2005, McMillan
6. Atlas, Principles of Microbiology, 2<sup>nd</sup> ed., 1997, McGraw-Hill

#### Bacteriology and Systematics Lab (BMI073A)

- 1) Gram staining
- 2) Negative staining for capsule
- 3) Flagella staining
- 4) Endospore staining
- 5) Acid fast staining
- 6) Explanation of Culture media and their types.
- 7) Demonstration of sterilization by moist heat using autoclave.
- 8) Preparation of culture media – liquid and solid media.
- 9) Demonstration of selective and differential media.
- 10) Demonstration of culture inoculation techniques – spread plate, streak plate and pour plate methods
- 11) Demonstrations of pure culture techniques – streak plate, pour plate and serial dilution method.
- 12) Demonstration of cultivation of Anaerobic bacteria.
- 13) Antibiotic sensitivity testing by disc diffusion method.
- 14) Bacterial growth curve formation by turbidity measurement method.

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Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI005C	Biochemistry	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

CO-1 Understand molecular interactions, basic chemical reactions and pH, characterize and understand the roles of biomolecules.

CO-2 Understand and apply the structure, properties and biological importance of carbohydrates and nucleic acids.

CO-3 Understand and apply the classification, chemical properties and biological importance of lipids.

CO-4 Analyze the classification, characteristics and structures of proteins and enzymes, inhibition & kinetics

CO-5 Understand the definition, classification, deficiency of vitamin and inborn error of metabolism

#### Unit I

Introduction to biochemistry, scope and importance Molecular interactions, Types of bonds, colligative properties of water, The concept of pH, dissociation and ionization of acids and bases. Henderson-hasselbalch equation, Classification and biological importance of biomolecules.

#### Unit II

Classification and biological importance of Carbohydrates, Monosaccharides; Disaccharides Oligosaccharides, Polysaccharides (Homo & Heteropolysaccharides). Nucleic acids, Biosynthesis of nucleotides. Base composition. A+T and G+C rich genomes.

#### Unit III

Classification and biological importance of lipids; Chemical properties and characterization of triglycerides, fats & fatty acids, Waxes, phospholipids and glycolipids.

#### Unit IV

Classification, structure, properties and biological importance of Amino acids and Proteins; biologically active peptides, structure of proteins-primary, secondary, tertiary and quaternary, Ramachandran plot. Nomenclature and classification of enzymes & enzyme units, Enzymes: as biocatalyst, classification, specificity, active site, enzyme kinetics (Michaelis and Menten equation) isozymes, coenzymes, factors affecting enzyme activity, enzyme inhibition.

#### Unit V

Definition and classification of vitamins, vitamin deficiency diseases, biochemistry, occurrence & functions of water soluble and fat soluble vitamins, Vitamins as coenzyme.

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# MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	2	0	2	3	2
CO2	1	3	3	1	3	2	1
CO3	2	3	2	1	3	1	2
CO4	2	3	2	1	2	1	2
CO5	2	2	1	0	1	2	2

3 = Highly Related; 2 = Medium; 1 = Low

## Suggested Readings:

1. Conn EE and Stumpf PK, Outlines of Biochemistry, 1976, John Wiley & Sons.
2. Nelson & Cox, Lehninger Principle of Biochemistry, 6<sup>th</sup> edition, 2013, W. H. Freeman Co.
3. Voet & Voet, Principles of Biochemistry, 4<sup>th</sup> edition, 2012, John Wiley & Sons.
4. Rastogi V.B. and Aneja K. R., Zubay's Principles of Biochemistry, revised edition, 2016, Medtec
5. Deb A.C., Fundamental of Biochemistry, 4<sup>th</sup> edition, 1990, new central book agency, Calcutta
6. Berg, Tymoczko and Stryer, Biochemistry, 7<sup>th</sup> edition, 2011, W.H. Freeman & Co Ltd
7. Satyanarayana U and Chakrapani U, Biochemistry, 5<sup>th</sup> edition, 2017, Elsevier.
8. Srivastava H.S., Element of Biochemistry, 2017, Rastogi Publications Meerut.
9. Jain J.L., Fundamentals of Biochemistry, 2017, S.Chand publishers New Delhi.

## Biochemistry Lab (BMI006C)

- 1) Qualitative test (Molisch's test) for presence of the carbohydrates in a given sample.
- 2) Iodine test for presence of Starch in a given sample.
- 3) Benedict's test for presence of reducing sugars in a given sample.
- 4) Fehling's test for presence of reducing sugars in a given sample.
- 5) Ninhydrin test for the presence of amino acids in a given sample.
- 6) Xanthoproteic test for the presence of aromatic amino acids in a given sample.
- 7) Biuret test for the presence of peptides or proteins in a given sample.
- 8) Solubility test for lipids.
- 9) Qualitative test for the presence of fatty acids by titrimetric method.
- 10) Determination of acid value of fats and oil.
- 11) Determination of iodine number of a fat sample.
- 12) Measurement of Riboflavin (Vitamin B2) in a given sample.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI074A	Mycology & Phycology	4	1	4	2	5

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**Course outcome (CO)** On completion of the course, students are able to:

- CO1- Understanding the diversity of the fungi
- CO2- Understanding the various fungus genera and its role in the environment.
- CO3- Analyze the application of the fungus products
- CO4- Understanding the various genera of algae.
- CO5- Analyze the various algae structure and its application.

#### Unit I

Characteristics, classification and cellular & thallus organization of fungi. General features, structure, nutrition, reproduction of different fungi group - Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Heterothallism and Parasexuality. Sex hormones in fungi, physiological specialization, phylogeny of fungi.

#### Unit II

General features, taxonomic status and evolutionary significance economic importance of important fungal genera - *Mucor*, *Saccharomyces*, *Neurospora*, *Agaricus*, *Fusarium*, *Alternaria*, *Curvularia* and *Cladosporium*. General account and importance of lichen. Important plant diseases caused by fungi- symptoms, disease cycles and control (Late & Early blight, Black rust, Smut, Wilt and Red rot).

#### Unit III

Role of fungi in biotechnology, Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Myco -proteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides). Mushroom and its cultivation.

#### Unit IV

General characteristics and evolution of algae. Occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eye- spot food reserves and vegetative, asexual and sexual reproduction. Classification of algae.

#### Unit V

General features, structure and reproduction and economic importance of *Chlamydomonas*, *Chlorella*, *Diatoms*, *Microcystis*, *Oscillatoria*, *Spirulina*, *Anabaena*, *Nostoc*, *Rivularia* and *Scytonema*. Mass cultivation of algae as a source of protein.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	0	0
CO2	2	3	0	2	2	1	1
CO3	3	3	2	2	2	1	2
CO4	2	2	0	2	1	0	0
CO5	3	2	1	2	2	0	2

3 = Highly Related; 2 = Medium; 1= Low



**Suggested Readings:**

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. *Introductory Mycology*. John Wiley, New York.
2. Mehrotra, R.S. and K.R. Anuja *An Introduction to Mycology*. New Age International Press, New Delhi.
3. Webster, J. *Introduction to fungi*. Cambridge University Press. Cambridge, U.K. (1985).
4. Bessey E.A. *Morphology and Taxonomy of fungi*. Vikas Publishing House Pvt. Ltd., New Delhi.
5. Jhon Webster and R W S Weber. *Introduction to Fungi*. Cambridge University Press 2007.
6. A. V. S. S. Sambamurty. *A Textbook of Algae*. I.K. International Publishing House Pvt. Limited, 2010
7. H.D. Kumar and H.N. Singh. *A Textbook on Algae* (Macmillan international college edition)

**Mycology & Phycology Lab (BMI075A)**

1. Preparation of Potato Dextrose Medium.
2. Isolation and identification of pathogenic and non-pathogenic fungi.
3. Isolation and identification of fungal plant pathogen from leaves, stems and other aerial parts of the plants.
4. Study of the symptoms and life cycle of important plant disease caused by fungi of classes – Myxomycetes, Oomycetes, Phycomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes
5. Study of host-pathogen interaction.
6. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor*, *Saccharomyces*, *Penicillium*, *Agaricus* and *Alternaria*
7. Purification and preservation of pure cultures of common algae and fungi.
8. Identification of edible and poisonous mushrooms.
10. Isolation and identification of blue-green algae from pond water.
11. Isolation and identification of algae from soil.
12. Determination of dual growth of *Chlorella* and *Chlorella* on agar plates.
13. Isolation and identification of cyanobacteria from pond water.
14. Demonstration of photosynthesis by algae.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI017C	Virology	4	1	4	2	5

**Course outcome (CO)**

On completion of the course, students are able to:

- |      |  |
|------|--|
| CO 1 | Understand the history, classification, morphology of virus. |
| CO2  | Understand the Bacteriophage and plant viruses.              |

stand the Bacteriophage and plant viruses.

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- CO 3 Understand the animal viruses, plant virus transmission and cultivation of viruses.  
 CO 4 Understand the Oncogenic and new emerging viruses in society.  
 CO 5 Applying the Preventive and control of viral diseases.

### Unit I

Brief history on discovery of virus. Nomenclature and classification (LHT and as per VII report of the international committee on taxonomy of viruses) Distinctive properties of virus. Morphology and ultrastructure (capsid, envelop and viral genome, their types and structure).

### Unit II

Virus related agents (viroids, Prions) Bacteriophage, (structural organization life cycle.) Plant Virus: Classification and nomenclature, lytic and lysogenic cycle of reproduction, general symptom and effect of virus on plant (paddy, tomato and sugarcane).

### Unit III

Animal viruses: Classification and nomenclature. Epidemiology, replication, pathogenicity prevention and treatment of RNA virus; Picorna virus, Rhabdovirus, HIV virus, Influenza Virus and DNA virus; Pox virus, Herpes virus, Hepatitis virus. Transmission of plant virus. Virus of cyanobacteria and fungi. Cultivation of virus on embryonated eggs, experimental animals and cell cultures

### Unit IV

Oncogenic and emerging viruses: Introduction to oncogenic viruses. Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes. Emerging viruses, their management and control strategies: H1N1, Chikungunya, Dengue, Ebola, Zika and Nipah virus, Covid 19.

### Unit V

Prevention and control of viral diseases: Antiviral compounds and their mode of action: AZT, aciclovir, ganciclovir. Interferons and their mode of action. General principles of viral vaccines: live attenuated vaccines, inactivated viral vaccine, subunit vaccine, recombinant viral vaccine.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	0	0	2	3	1	1
CO2	2	3	1	2	2	3	1
CO3	3	3	2	1	2	2	1
CO4	3	2	2	2	3	2	1
CO5	2	0	1	3	3	1	1

3 = Highly Related; 2 = Medium; 1 = Low

### Suggested Readings:-

1. Dimmock NJ, and Primrose SB., Introduction to Modern Virology. 4<sup>th</sup> edition 1994, Blackwell Science Ltd.
2. Dimmock, NJ, Easton, AL, Leppard, KN, Introduction to Modern Virology. 6<sup>th</sup> edition, 2007, Blackwell Publishing Ltd.
3. Carter J and Saunders V, Virology: Principles and Applications, 2007, John Wiley and Sons.

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4. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM Principles of Virology, Molecular biology, Pathogenesis and Control. 2<sup>nd</sup> edition, 2004, ASM press Washington DC.
5. Levy JA, Conrat HF, Owens RA., Virology. 3<sup>rd</sup> edition, 2000, Prentice Hall publication.
6. Wagner EK, Hewlett MJ., Basic Virology, 2<sup>nd</sup> edition, 2004, Blackwell Publishing.
7. Mathews., Plant Virology, 2004, Hull R. Academic Press, New York.
8. Nayudu MV., Plant Viruses, 2008, Tata McGraw Hill, India.
9. Bos L., Plant viruses-A text book of plant virology by 1999. Backhuys Publishers.
10. Versteeg J., A Color Atlas of Virology, 1985, Wolfe Medical Publication.

### Virology Lab (BMI018C)

1. Demonstration of the diseases of plants caused by viruses viz. Tobacco Mosaic Disease and Cucumber Mosaic disease.
2. Demonstration of the human diseases caused by viruses viz. AIDS, Mumps, Small pox and Chicken pox etc.
3. Demonstration of different types of plant viruses.
4. Demonstration of different types of animal viruses.
5. Cultivation of animal viruses in embryonated eggs.
6. Demonstration of Plaque test for the bacteriophages.
7. Case study of Pandemic COVID-19, MERS-CoV, Ebola virus disease, Zika virus disease, H1N1 Swine Flu disease, AIDS

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI029C	Microbial Physiology	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

- CO1-Understand the nutrition type and transport of nutrients in microorganism.
- CO2-Understand the different physiological pathways and cycles in microbes.
- CO3-Analyze the chemolithotrophy and photosynthesis in bacteria.
- CO4-Analyze the assimilation and disassimilation of nitrogen bacteria in environment.
- CO5-Apply the environmental trends on bacterial growth.

### Unit I

Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake

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## Unit II

Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

## Unit III

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and Cyanobacteria.

## Unit IV

Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Introduction to biological nitrogen fixation Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

## Unit V

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve. Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermotolerants, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	3	2	0
CO2	3	3	0	0	2	2	1
CO3	2	1	0	1	3	3	0
CO4	2	2	1	0	3	2	0
CO5	2	1	0	1	2	2	1

3 = Highly Related; 2 = Medium; 1 = Low

### Suggested Reading:

1. Devlin R. M. and Witham F. H., Plant Physiology. 4<sup>th</sup> edition, 1987, Belmont; Calif.; Wadsworth
2. Gottschalk G., Bacterial Metabolism, 2<sup>nd</sup> edition, 1986, Springer
3. Madigan M. T., Martinko J. M. and Parker J., Brock Biology of Microorganisms. 11<sup>th</sup> edition, 2005, Pearson/ Benjamin Cummings.

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4. Moat A. G., Foster J. W., Spector M.P., Microbial Physiology. 4th edition, 2002, John Wiley & Sons.
5. Reddy S. R. and Reddy S. M., Microbial Physiology, 2008. Scientific Publishers India.
6. Stanier R.Y., Ingraham J.L., Wheelis M.L. and Painter P. R., General Microbiology, 5<sup>th</sup> edition, 2005, McMillan
7. Willey J.M., Sherwood L.M., Woolverton C.J., Prescott, Harley and Klein's Microbiology, 9th edition, 2014, McGraw Hill Publishers.

### Microbial Physiology Lab (BMI030C)

- 1) Demonstration of effect of temperature on bacterial growth.
- 2) Demonstration of effect of pH on bacterial growth.
- 3) Demonstration of effect of salt/sugar concentration on bacterial growth.
- 4) Demonstration of metals on bacterial growth.
- 5) Amylase production test.
- 6) Effect of carbon and nitrogen sources on growth of *E.coli*.
- 7) Demonstration of alcoholic fermentation.
- 8) Measurement of bacterial growth by turbidity measurements.
- 9) Preparation of growth curve for bacterial growth in a batch culture and calculate the mean generation time (doubling time).
- 10) Demonstration of the thermal death time and decimal reduction time of *E.coli*.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI022C	Microbial Genetics	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

- CO1-Understand the organization of prokaryotic Genomes.
- CO2-Understand the process and mechanism of genetic exchange.
- CO3-Understand the molecular mechanism of gene regulation in prokaryotes.
- CO4-Understand the different cycles of bacteriophages.
- CO5-Understand the different aspects of bacteriophage genetics.

### Unit I

Prokaryotic Genomes - Physical organization of bacterial genomes (Structure of the bacterial nucleoid, Replication and partitioning of the bacterial genome and Genome of Archaea). Mutations and mutagenesis: Definition and types of Mutations, Physical and chemical mutagens.

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## Unit II

Mechanism of genetic exchange : Plasmid, Types of plasmids (F Plasmid : a Conjugate plasmid', Mobilization of Non-conjugative plasmid, R plasmid, Col plasmid Copy number and incompatibility), Episomes. Transposable elements (Insertion sequence and transposons, Integrons and Antibiotic-Resistance cassettes, Multiple Antibiotic Resistant bacteria, Mu-virus);

## Unit III

Molecular Mechanism of gene regulation in prokaryotes - Transcriptional regulation in prokaryotes (inducible and repressible system, positive regulation and negative regulation); Operon concept – lac, trp, Ara operons. Bacterial Genetics (Mutant phenotype, DNA mediated Transformation; Conjugation (Cointegrate Formation and Hfr Cells, Time-of-Entry Mapping, F' Plasmid); Transduction (Generalized transduction, Specialized Transduction)- gene mapping.

## Unit IV

Bacteriophages: Stages in the Lytic Life Cycle of a typical phage, Properties of a phage infected bacterial culture, Specificity in phage infection, E. coli Phage T4, E.coli Phage T7, E.coli phage lambda, Immunity to infection, Prophage integration, Induction of prophage, Induction & Prophage excision, Repressor, Structure of the operator and binding of the repressor and the Cro product, Decision between the lytic and lysogenic Cycles, Transducing phages, E.coli phage phiX174, The lysogenic Cycle.

## Unit V

Bacteriophage Genetics - Benzer's fine structure of gene in bacteriophage T4 : Plaque Formation and Phage Mutants, Genetic recombination in the lytic cycle, (concept of recon, muton, cistron).

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	1	2	3
CO2	3	2	1	2	1	2	1
CO3	2	2	1	2	0	1	1
CO4	1	3	1	0	1	2	0
CO5	1	1	3	2	1	0	1

3 = Highly Related; 2 = Medium; 1 = Low

### Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P., 8<sup>th</sup> edition, 2008, Principles of Genetics, Wiley India
2. Karp G, Cell and Molecular Biology, 4th edition, 2005, John Wiley and Sons
3. Elliott W H and Elliot D C, Biochemistry and Molecular Biology, 3<sup>rd</sup> edition, 2005, Oxford University Press
4. Malacinski G.M. and Freifelder D., Essentials of Molecular Biology, 3<sup>rd</sup> edition, 1998, Jones and Bartlett Publishers
5. Scheeler P. and Bianchi D.E., Cell and Molecular Biology, 3<sup>rd</sup> edition, 1987, John Wiley and Sons
6. Maloy S.R., Cronnan J.E., Freifelder D., Microbial Genetics, 2<sup>nd</sup> edition, 1994, Jones and Bartlett

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### Microbial Genetics Lab (BMI023C)

- 1) Isolation of antibiotic resistant bacteria population by gradient plate method.
- 2) Isolation of antibiotic resistant mutants by Replica plating technique.
- 3) Demonstration of genetic recombination in bacteria by conjugation.
- 4) UV-induced auxotrophic mutants production and isolation of the mutants by replica plating.
- 5) Demonstration of genetic recombination in bacteria by transduction.
- 6) Demonstration of genetic recombination in bacteria by transformation.
- 7) Demonstration of carcinogens/mutagens by the Ames test.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI024B	Biostatistics	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

CO1-Evaluate the frequency distribution by data and graphical methods.

CO2- Evaluate the measure of central tendency.

CO3- Evaluate the dispersion from the data.

CO4- Evaluate the statistical inference tools.

CO5- Evaluate the correlation and regression analysis.

#### Unit I

Introduction, Definition, Functions, scope and application of biostatistics. Understanding the concepts of descriptive and inferential statistics. Frequency distribution, Collection of data : Primary and secondary data, tabulation of data, discrete and continuous series. Graphical presented : Types of diagrams, Graphs of frequency distribution- Bar diagrams, Histogram, frequency Polygon, smooth frequency curve, Ogives.

#### Unit II

Measures of Central Value, Introduction, Definition and Limitation of Average; Mathematical Average-Mean; Arithmetic, Geometric, Harmonic and Positional Average- Mode, Median.

#### Unit III

Measures of Dispersion, Introduction, Definition, various measures of variation; Range, Quartile deviation, Mean Deviation, Standard Deviation, Variance.

#### Unit IV

Statistical Inference, Testing of Hypothesis ; Procedure, test of significance of mean; Standard error of mean and standard deviation ; student's 't' test , chi-square test.

#### Unit V

Correlation, Introduction, definition, kinds- negative, positive and zero correlation, coefficient of

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correlation, methods of studying correlation-scatter diagram, Graphical method, Karl pearson's coefficient of correlation. Regression Analysis, Introduction, definition, regression equation, regression lines and regression coefficients.

#### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	3	2	2	1	2	2
CO2	1	2	3	1	0	3	1
CO3	1	3	2	1	0	2	1
CO4	1	2	3	2	0	3	1
CO5	1	3	3	2	1	3	2

3 = Highly Related; 2 = Medium; 1 = Low

#### Suggested Readings:

1. Edmondson and Druce D., Advanced Biology Statistics, 1996, Oxford University Press;.
2. Danial W., Biostatistics: A foundation for Analysis in Health Sciences, 2004, John Wiley and Sons Inc.
3. Gupta S.C. and Kapoor V.K., Fundamental of mathematical Statistics, 2017, sultan chand & sons
4. Sundar Rao P.S.S. and Richard J., Introduction to biostatistics and research methodology, 5<sup>th</sup> edition, 2012, PHI Learning Pvt. Ltd.
5. Banarjee P.K. , Introduction to biostatistics, 3<sup>rd</sup> edition, 2006, S. Chand Publication, India
6. Rastogi V.B. Biostatistics, 3<sup>rd</sup> revised edition, 2015, Rastogi publication

#### Biostatistics Lab (BMI025B)

- 1) Construction of frequency tables.
- 2) Exercises on data interpretation using histograms, polygons and pie- charts.
- 3) Exercises on Airthematic mean, geometric mean and harmonic mean
- 4) Exercises on median.
- 5) Exercises on mode.
- 6) Exercises on the testing of hypothesis using student t test.
- 7) Exercises on the testing of hypothesis using Chi-square test.
- 8) Exercises on computing correlation coefficient.
- 9) Exercises on computing regression coefficient.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI076A	Genetic Engineering	4	1	4	2	5

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CO1- Understand the various tools and methods used in genetic engineering.

CO2- Understand that how genetic tools useful in cloning and genetic transformation.

CO3- Understand the cloning vectors uses, its formation and various types of vectors used in genetic engineering.

CO4- Understand the DNA amplification technique through PCR and DNA sequencing technique.

CO5- Apply the knowledge of genetic engineering in Gene delivery and production of transgenic progeny's.

**Introduction to genetic engineering:** Milestones in genetic engineering and biotechnology  
**Restriction modification systems:** Mode of action, applications of Type II restriction enzymes in genetic engineering. **DNA modifying enzymes and their applications:** DNA polymerases, Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases

Cloning: Use of linkers and adaptors: Transformation of DNA: Chemical method, Electroporation. Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE, and Western blotting

**Cloning Vectors: Definition and Properties** Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Expression vectors: E.coli lac and T7 promoter-based vectors, yeast YIp, YE<sub>p</sub> and YC<sub>p</sub> vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

DNA Amplification and DNA sequencing: PCR: Basics of PCR, RT-PCR, Real-Time PCR  
Genomic and cDNA libraries: Preparation and uses, Genome sequencing Sanger's method of  
DNA Sequencing: traditional and automated sequencing

Application of Genetic Engineering: Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, *Agrobacterium* - mediated delivery. Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, flavosavo tomato, Gene therapy, recombinant vaccine, protein engineering.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	2	1	1
CO2	2	2	2	2	1	2	2
CO3	2	3	3	1	2	2	1
CO4	3	3	2	1	3	1	1
CO5	2	2	3	2	3	1	1

3 = Highly Related; 2 = Medium; 1 = Low

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**Suggested Reading:**

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).  
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc. (2002).  
3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).  
4. Watson J.D, Baker T.A, Bell S.P, Gann A, Levine M, Losick R, Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc. (2003).  
5. David Frifielder, Stanely R. Maloy, Molecular biology and Microbial genetics. 2nd Edition, Jones and Barlett Publishers. (1994)  
6. Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).  
7. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).  
8. Glick BR and Pasternak JJ, Molecular Biotechnology, 2nd Ed. ASM press. (2003).  
9. Uldis N. Streips, Ronald E. Yasbin. Modern Microbial Genetics. 2nd Edition Wiley-Liss, Inc. (2002).  
10. Desmond S. T. Nicholl. An Introduction to Genetic Engineering. Cambridge University Press; (2008)

**Genetic Engineering Lab (BMI077A)**

- 1) Isolation of Plasmid DNA from *E.coli*.
- 2) Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
- 3) Ligation of DNA fragments
- 4) Interpretation of sequencing gel electropherograms
- 5) Designing of primers for DNA amplification
- 6) Amplification of DNA by PCR
- 7) Demonstration of Southern blotting

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI047A	Project Work on Microbiology of Societal Importance	-	-	-	-	6

Course learning outcomes: By the conclusion of this course, the students:

**Outcome 1.** Have developed a very good understanding of areas where microbiology has social importance.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOME:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	3	3

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Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI078A	Agriculture and Veterinary Microbiology	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

CO1-Understanding of the multifarious roles of microorganisms in soil, in association with plants and thus in the field of agriculture.

CO2-Understand the Importance of agriculture in national economy and cultivation of various crops.

CO3-Understand the role of Major pests and diseases of rice, wheat, cotton, chickpea, sugarcane and their management

CO4-Understand the animal diseases with respect to etiology, symptoms, mode of transmission, prophylaxis and control.

CO5-Understand the importance of Elementary Livestock Handling.

### Unit-I

History of Agricultural Microbiology; Microbes and their importance in maintenance of soil, Biogeochemical cycles, role of microbes in maintaining the fertility of soil. Bio fertilizers – Bacterial, - Azotobacter and vermiform compost. Soil microorganism –association with vascular plants- phyllosphere, Rhizobium, Rhizoplane associative nitrogen fixation. Biofertilizers- Cyanobacterial and Azolla.

### Unit -II

Importance of agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, chickpea, pigeon-pea, sugarcane, groundnut, tomato, and mango. Major soils of India; role of NPK and their deficiency symptoms. Elementary knowledge of growth, development, photosynthesis, respiration and transpiration; Elements of economic botany

### Unit – III

Major pests and diseases of rice, wheat, cotton, chickpea, sugarcane and their management. Organic farming; bio-fertilizers; bio-pesticides. Recombinant DNA technology; transgenic crops. Important rural development programmes in India; organizational set up of agricultural research, education and extension in India. Elements of statistics.

### Unit IV

Study of following animal diseases with respect to etiology, symptoms, mode of transmission, prophylaxis and control: FMD, swine flu, bird flu, Rabies, bovine tuberculosis, Marek's, ranikhet, brucellosis, distemper

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## Unit V

Elementary Livestock Handling: An overview of animal behaviour, Common tools used for animal control; Restraint and handling of animals, Nutrition Principles of animals nutrition; Nutritional importance of carbohydrates, lipids, proteins, vitamins, minerals and water; Feeds and fodders; Scientific feeding of livestock.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	3	1	1
CO2	2	1	2	1	2	2	1
CO3	3	1	1	2	3	3	2
CO4	2	3	2	2	2	1	3
CO5	2	1	3	1	1	1	1

### Suggested Readings:

1. Stanbury, PF., Principles of Fermentation Technology. Whittaker, A and Hall, S.J 2<sup>nd</sup> Edition. Pergamon Press (1995).
2. Banwart, GJ. Basic Food Microbiology. CBS Publishers and Distributors, Delhi. (1989).
3. Hobbs BC and Roberts D. Food poisoning and Food Hygiene. Edward Arnold (A division of Hodder and Stoughton) London.
4. Joshi. Biotechnology: Food Fermentation Microbiology, Biochemistry and Technology. Volume 2.
5. Arora MP. 1995. Animal Behaviour. WB London. Bouenger EG. 1994.
6. Animal Behaviour. WB London. Fraser AF & Broom DM. 1997.
7. Farm Animal Behaviour and Welfare. CABI. Fraser AF & Broom DM. 1999.

### Agriculture and Veterinary Microbiology Lab (BMI079A)

- 1) MBRT of milk samples and their standard plate count.
- 2) Alkaline phosphatase test to check the efficiency of pasteurization of milk.
- 3) Various livestock farming units and their economic analysis.
- 4) Evaluation of different farming systems and their economic importance.
- 5) Analysis of breeding, feeding, housing - Disease control management.

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Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI080A	Advance Microbiology	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

CO1- Define the cell structural organization and function of cell organelles.

CO2- Define the structure and chemical composition of centrioles and mitochondria.

CO3- Describe the membrane transport system and chromosomal organization of eukaryotes and prokaryotes.

CO4- Write about photosystem and structural assembly of plastids, cilia and flagella.

CO5- Describe the cell cycle, cell division and its significance.

#### Unit-1

Evolution of Microbial Genomes: Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pan genome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

#### Unit-2

Metagenomics: Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using Metagenomics Basic knowledge of viral metagenome, meta transcriptomics, metaproteomics and metabolomics.

#### Unit-3

Molecular Basis of Host-Microbe Interaction: Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance

#### Unit-4

Systems and Synthetic Biology: Networking in biological systems, Quorum sensing in bacteria, Coordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

#### Unit-5

Microbiomes and importance of microbial communities, VBNC (viable but not culturable bacteria). Genetically modified organisms and their uses. Modern methods of rapid identification of microbes (PCR, mass spectrometry, fluorescence based techniques). CRISPR-Cas system.

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**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	1	1	2
CO2	2	2	1	1	2	1	1
CO3	2	2	2	2	2	2	1
CO4	2	2	1	2	3	1	1
CO5	3	1	1	1	2	2	2

**Suggested Readings:**

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc, (2002).
3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
4. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R., Molecular Biology of Gene, 5<sup>th</sup> Edition. The Benjamin/Cummings Pub. Co. Inc (2003).
5. David Frifielder, Stanley R. Maloy, Molecular biology and Microbial genetics. 2<sup>nd</sup> Edition, Jones and Barlett Publishers. (1994).
6. Brown T.A., Gene Cloning and DNA analysis. 2<sup>nd</sup> Edition, ASM press. (2004).
7. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7<sup>th</sup> Ed., Blackwell Publishers. (2006).
8. Glick BR and Pasternak JJ, Molecular Biotechnology, 2<sup>nd</sup> Ed. ASM press. (2003).

**Advanced Microbiology Lab (BMI081A)**

- 1) Extraction of metagenomics DNA from soil.
- 2) Understand the impediments in extracting metagenomics DNA from soil.
- 3) PCR amplification of metagenomics DNA using universal 16s ribosomal gene primers.
- 4) Case study to understand how the polio virus genome was synthesized in the laboratory.
- 5) Case study to understand how networking of metabolic pathways in bacteria take place

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### Discipline Specific Electives

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI 082A	Fundamentals of Food Microbiology	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the food microorganism and its classification and importance.

CO2- Apply the principle of food preservation and removal of microorganism.

CO3- Understand and analyze about microorganism responsible for food contamination and spoilage.

CO4- Analyze the food infection and intoxication.

CO5- Understand and apply the health standard, fermentation of food and, disposal and treatment process.

#### Unit I

Microorganisms important in food microbiology; Molds, yeasts and bacteria - General Characteristics - Classification and importance, Nutritional requirements of bacteria and fungi.

#### Unit II

Principles of food preservation - Asepsis - Removal of micro organisms, anaerobic conditions - High temperature - Low temperature - Drying - Food additives

#### Unit III

Contamination and spoilage - Cereals, sugar products, vegetables and fruits, meat and meat products, milk and milk products - Fish and sea food - Poultry, Spoilage of canned foods. Spoilage and defects of fermented dairy products - oriental fermented foods

#### Unit IV

Food borne infections and intoxications - bacterial, non -bacterial - Food borne disease outbreaks, Laboratory testing, preventing measures, Food sanitation, plant sanitation

#### Unit V

Employees' health standards, waste treatment and disposal, quality control, Food fermentations : Bread cheese, vinegar, fermented vegetables, fermented dairy products

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	0	2	3	0	0
CO2	0	0	1	1	0	1	3
CO3	3	0	0	3	0	0	2
CO4	0	0	0	0	0	3	1

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CO5	2	0	0	0	0	1	0
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3 = Highly Related; 2 = Medium; 1 = Low

### Suggested Readings:

1. Adams MR and Moss MO, Food Microbiology, Revised edition, 2008, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM, Basic Food Microbiology. 2<sup>nd</sup> edition, 2004, CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL, Antimicrobials in Foods. 1993, Marcel Dekker, New York.
4. Dillion VM and Board RG, Natural Antimicrobial Systems and Food Preservation, 1996, CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC, Food Microbiology. 3<sup>rd</sup> edition, 1992, Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. New Methods of Food Preservation, 1995, Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA, Modern Food Microbiology. 7<sup>th</sup> edition, 2005, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW, The Microbiological Safety and Quality of Foods. Vol.1-2, 2000, ASPEN Publication, Gaithersburg, MD.
9. Tortora GJ, Funke BR, and Case CL, Microbiology: An Introduction. 9<sup>th</sup> edition, 2008, Pearson Education.

### Fundamentals of Food Microbiology Lab (BMI083A)

- 1) Determination of quality of milk sample by methylene blue reductase test.
- 2) Detection of number of bacteria in milk by standard plate count (SPC).
- 3) Alkaline phosphate test to check the efficiency of pasteurization of milk.
- 4) Production of yogurt/curd.
- 5) Isolation of spoilage microorganisms from spoiled milk.
- 6) Isolation of spoilage microorganisms from spoiled fruits and vegetables.
- 7) Isolation of spoilage microorganisms from spoiled bread.
- 8) Production of bread.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI084A	Food Chemistry	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

CO1 Understand the properties and reactions of carbohydrates, lipids and proteins during storage and processing of foods and the effect of these on the quality and property of foods.

CO2 Analyze the main factors influencing the colour and flavour of food.

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- CO3 Understand the composition of foods and the effect of these factors on foods.  
CO4 Evaluate large scale and profit motivated production of microorganisms or their products for direct use or as inputs in the manufacture of other products.  
CO5 Understand the process of browning reactions in food.

### Unit I

Introduction to Chemistry of Foods : Carbohydrates Composition and factors affecting composition of foods - Moisture in foods and determination of moisture - Carbohydrates - Chemistry of cellulose, starches, other polysaccharides - starch enzymes, Gel formation and starch degradation - Pectic substances, their occurrence structure, properties and use in foods - Plant acids, acidity, taste

### Unit II

Classification of proteins, physical and chemical properties of proteins, functional properties of proteins in foods, hydrolysis of proteins - Major food - Proteins and their sources, Changes in proteins during processing - Determination of Proteins

### Unit III

Physical and chemical properties of fats, rancidity and flavour reversion, processing of oil bearing materials, refining of oils and fats, fat hydrolysis and inter-esterification, hydrogenation, shortenings and spreads - Emulsions, Definition, surface activity, surface film theory of emulsions, properties and types of emulsions, emulsifying agents, their chemistry during processing - Essential oils, Chemistry of occurrence, Extraction - Terpene oils and their use in foods.

### Unit IV

Cereals: Cereal varieties and their suitability for processing - Structure of wheat, rice - Chemical compositions and nutritional values of prominent cereals; Distribution of vitamins, proteins, minerals, carbohydrates and fats in different grains Pulses: Nutritional value of prominent pulses (Moong, Redgram, lentil, black gram and soyabeans) Oilseeds: Chemical composition and nutritional value of prominent oilseeds (Sunflower mustard, cotton seed, ground nut, cashewnut and coconut) - Distribution of vitamins, proteins, minerals, carbohydrates and fats in different oilseeds

### Unit V

Browning Reactions in Foods, Nonenzymatic Browning, Pigment Formation, Melanoidin - Maillard Polymers, Caramelization, Ascorbic Acid Oxidation, Antioxidant Activity of Nonenzymatic Browning Products, Inhibition of nonenzymatic browning.



  
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**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1	1	1	1	2	1
CO2	2	2	1	0	0	1	2
CO3	3	1	2	1	1	1	2
CO4	2	2	1	0	1	1	3
CO5	3	3	2	1	0	2	1

3 = Highly Related; 2 = Medium; 1 = Low

**Suggested Readings:**

1. Food Science and experimental foods, Swaminathan, N. (1987) Ganesh Publications, Madras.
2. Food chemistry, Meyer L.M.(1969) Van Nostrand Reinhold co., New York.
3. Foundations of Food Preparation, Peckham, C.G. (1979), The Macmillan co., London.
4. Food Theory and Applications, Paul P.C. and Palmer H.H. (1972), John Wiley and Sons, New York.
5. The experimental study of foods, Griswald R.M. (1962), Houghton, Muffin Co., New York.
6. Introductory foods, Bennion M. and Hughes, D. (1975), Macmillan publishing Co., New York.
7. Food facts and principles, Sakuntala Manay and Shadaksaraswamy, M (1987) Allied Publishers, New Delhi.

**Food Chemistry Lab (BMI085A)**

1. Systematic identification of biomolecules – Qualitative tests for amino acids and protein - Biuret test, Millon's test, Nitroprusside test, Ninhydrin test, Sakaguchi test.
2. Qualitative test for carbohydrates - Molisch's test, Bial's test, Benedicts test, Barfoeds test, Fehlings test, Seliwanof's test, Mucic acid test, Iodine test.
3. Qualitative test for Lipids - acrolein test, test for saturation, test for unsaturation, saponification test
4. Qualitative test for NPN substances - Urease test, Phosphotungstic acid test, Jaffes test, Uric acid test.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI086A	Food Packaging Technology	4	1	4	2	5

Course outcome (CO)

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On completion of the course, students are able to:

CO1 Understand the fundamentals of packaging technology.

CO2 Understand the safety evaluation of materials used for packing.

CO3 Apply and examine the knowledge of properties for selection of packaging materials for foods & food product.

CO4 Analyze the different techniques of food packaging.

CO5 Understand the packaging equipments and machinery.

### Unit I

Introduction of Food packaging - Need of food packaging - Role of packaging in extending shelf life of foods - Designing of package materials - Testing of package materials - Testing of package performance - Principles in the development of safe and protective packing - Safety assessment of food packaging materials

### Unit II

Food packaging systems, product characteristics and package requirements - Introduction of food packaging system - Different forms of packaging - Rigid, semi-rigid, flexible forms of packaging - Different packaging system for-Dehydrated foods, Frozen foods, Dairy products, Fresh fruits, Vegetables, Meat, Poultry, Sea foods

### Unit III

Types of packaging materials their characteristics and uses - Use of paper as a packaging material-Pulping - Fibrillation, Beating, Types of papers ,Testing methods - Use of glass as a packaging material-Composition, Properties, Types, Methods of bottle making - Use of metals as a packaging material - Tinplate containers, Tinning process, Components of tinplate, Tin free steel (TFS), Types of cans, Aluminium containers, Lacquers - Use of plastics as a packaging material-Types of plastics, Plastic films, laminated plastic materials, Co-extrusion

### Unit IV

Package accessories and advances in Packaging technology-Introduction - Active packaging - Modified atmosphere packaging-Controlled atmosphere packaging - Aseptic packaging - Packages for microwave ovens - Biodegradable plastics - Edible gums - Coatings

### Unit V

Packaging equipment and machinery- Vacuum packaging machine - CA & MA packaging machine - Gas packaging machine - Seal and shrink packaging machine - Form & fill sealing machine - Aseptic packaging systems - Retort pouches - Bottling machines - Carton making machines - Package printing machines

#### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	1	2	1	2
CO2	1	1	1	2	1	2	1
CO3	2	2	3	1	2	1	2
CO4	1	1	1	2	1	1	2

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CO5	2	2	3	1	1	1	1
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3 = Highly Related; 2 = Medium; 1 = Low

#### Suggested Readings:

1. Srilakshmi, B., 2005, Food Science., New Age International (P) Limited., New Delhi.
2. Subalakshmi, G and Udipi, S.A, 2001, Food processing and preservation. New Age International Publishers, New Delhi.
3. Potter, N. N, Hotchkiss, J. H, 2000 Food Science. CBS Publishers, New Delhi.
4. Manay, N.S, Shadaksharaswamy, M., 2004, Foods- Facts and Principles, New Age International Publishers, New Delhi
5. Miquel Angelo P R C, Ricardo Nuno C P, Oscar Leandro D S R, Jose Antonio C T, Antonio Augusto V , 2016, Edible Food Packaging: Materials and Processing Technologies, CRC Press. Taylor & Francis, Boca Raton, FL
6. Luciano P, Sara L, 2016, Food Packaging Materials, Springer cham Heidelberg, New York
7. Robertson, G.L. 2006 Food Packaging: Principles and Practice (2nd ed.), Taylor & Francis
8. NIIR. (2003). Food Packaging Technology Handbook, National Institute of Industrial Research Board, Asia Pacific Business Press Inc.

#### Food Packaging Technology Lab (BMI087A)

- 1) To measure the thickness of a paper and paper boards used in packaging
- 2) To measure water absorption capacity of packaging paper
- 3) To measure the bursting strength of a packaging paper
- 4) To determine the static and dynamic tensile strength of a packaging paper
- 5) Determination of water vapour permeability (WVTR) of packaging material.
- 6) To find the amount of coating in a tin plate
- 7) Determination of a gas transmission rate of packaging material

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI088A	Food Quality and Foodborne Diseases	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

- CO1- Evaluate the different sensory methods used for the quality determination of various foods.  
 CO2- Perform various tests to detect the presence of adulterants in foods.  
 CO3- Understand the various food laws and standards.  
 CO4- Understand the various lab practices in food quality  
 CO5- Understand the importance of Quality Control and Quality Assurance.

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### Unit I

Bacterial : Food Poisoning by *Staphylococcus*, *Clostridium perfringens*, *Clostridium botulinum*, *Salmonella*, *Brucella*, *E. coli*, *Shigella*, *Bacillus cereus*, *Yersinia enterocolitica*, *Vibrio cholerae*, *Listeria monocytogenes* - Fungi - Mycotoxins - Aflatoxin, ochratoxin, trichothecenes, Roquefortine. - Protozoas : *Entamoeba histolytica*, *Giardia*; Seafood Toxicants: Shellfish poisoning - ciguatera poisoning - scombroid fish poisoning - viral gastroenteritis, infectious hepatitis, poliomyelitis, Viral Diarrhoea - Rotavirus - Norwalk virus Control of food borne diseases

### Unit II

Sensory evaluation - definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects-factors affecting food acceptance-terminology related to sensory evaluation - scoring procedures: types of tests -panel selection-screening and training of judges-requirement of sensory evaluation-sampling procedures-factors affecting sensory measurements. Chemical methods used in quality evaluation-Moisture, PR, HM, TVBN, Peroxide value, Acidity/ acid value detection of adulterants, Microbiological evaluation

### Unit III

Food laws and standards - Food regulations, grades and standards - Food safety objectives - National food legislation/ authorities and their role - product certifications: ISI mark of BIS, AGMARK, FPO, MFPO, international organization and agreements-food and agricultural organization (FAO), Concept of Codex Alimentarius/HACCP /USDA/ISO 9000 series /ISO22000 / Government regulatory practices and policies/FDA perspectives / PFA act and rules - Food Packaging and labelling

### Unit IV

Introduction, principles of sanitation, sanitation chemicals, disinfectants, sanitation methodology, sanitation procedures, CIP and COP- evaluating the effectiveness of sanitation programmes - Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry - Regulatory aspects of quality control - ISO, WHO and US certification

### Unit V

Importance and functions of quality control - Methods for quality assessment - Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization) - Sampling and specification of raw materials and finished products - Statistical quality control - A comparison of Quality Control and Quality Assurance - Use of microbiology methods in a Quality-Control system - Use of microbiology methods in a Quality Assurance system

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	1	2	1	2
CO2	1	1	1	2	1	2	1
CO3	2	2	3	1	2	1	2
CO4	1	1	1	2	1	1	2
CO5	2	2	3	1	1	1	1

3 = Highly Related; 2 = Medium; 1 = Low

**Suggested Readings:**

1. Read G. and Nogodwanithana (1991), Yeast Technology, 2<sup>nd</sup> Edition, AVI Book, Van Nostrand, Reinhold, New York.
2. Lee B.H. (1996), Fundamental of Food Biotechnology, VCH Publishers.
3. Goldberg I. and Williams R. (1991), Biotechnology and Food Ingredients, Van Nostrand., Reinhold, New York.
4. Joshi V.K. and Pandey A. (1999), Biotechnology: Food Fermentation Vol. 1 & 2, Education Publisher and Distributer, New Delhi.
5. Marwaha S.S. and Arora, J.K. (2000), Food Processing: Biotechnological applications, Asia tech Publishers Inc., New Delhi.
6. Frazier W. C. and Westhoff D.C. (1995). Food Microbiology. Fourth Edition. Tata McGraw Hill Publishing Company Limited, New Delhi
7. Adams M.R. and M.O. MOSS (2005). Food Microbiology. 1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi

**Food Quality and Foodborne Diseases Lab (BMI089A)**

- 1) To find out the ash in the given food sample
- 2) To find out the amount of crude protein in a given food sample
- 3) To find out the amount of crude fiber in a given food sample
- 4) Sensory Evaluation of a food product by Preference Test-Hedonic Rating Scale
- 5) Sensory Evaluation of a food product by Descriptive Rating Test- Star Diagrams
- 6) To examine total plate count of given food sample.
- 7) To identify the gut micro biota in given food sample through specific medium

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI090A	Dairy Microbiology	4	1	4	2	5

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### Course outcome (CO)

On completion of the course, students are able to:

- CO1-Understand the pathogenic microorganisms transmitted through raw milk.
- CO2-Understand the preservation technique of milk
- CO3-Analyze the composition of starter cultures and their use in dairy products
- CO4-Analyze the various type of disease transmitted by raw milk.
- CO5-Analyze the culture dependent and culture independent techniques for quantification of microorganisms from dairy products.

#### Unit I

Composition of milk of different animals – classes of milk - Microorganisms of concern in milk - Factors influencing microbial growth in milk - antibacterial properties of milk - Scope of dairy microbiology

#### Unit II

Preservation techniques in milk and milk based products – Asepsis, removal of microorganisms, anaerobic conditions, high and low temperatures, drying, irradiation, Chemical and bio preservatives and food additives

#### Unit III

Products from milk: market milk – condensed and dry milk products –frozen desserts Fermented Dairy Products: Starter cultures: their isolation, production, maintenance, biochemical characters - Products: Cream Cheese, yogurt, butter and Indigenous dairy products of India – probiotic dairy products

#### Unit IV

Human pathogens transmitted through raw milk and other dairy products: *Bacillus cereus*, *Campylobacter jejuni*, *Escherichia coli* O157:H7, *Listeria monocytogenes*, *Salmonella spp.*, *Yersinia enterocolitica*. Diseases transmitted through milk: brucellosis, tuberculosis, Q fever

#### Unit V

Quality analysis of milk: platform tests in milk - SPC, MBRT, alkaline phosphatase test, Resazurin test, clot on boiling test, titratable acidity, butter fat content test - FSSAI standards of milk - PMO – MMPO

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	1	3	3	1	2
CO2	3	2	2	1	1	2	1
CO3	2	1	3	3	2	1	2
CO4	3	2	3	2	1	2	2
CO5	2	2	1	2	2	1	1

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3 = Highly Related; 2 = Medium; 1 = Low

### Suggested Readings:

1. Frazier W. C. and Westhoff D.C. (1995). Food Microbiology. Fourth Edition. Tata McGraw Hill Publishing Company Limited, New Delhi
2. Adams M.R. and M.O. MOSS (2005). Food Microbiology. 1st edition. Reprinted, Published by New Age International (P) Limited. Publishers - New Delhi
3. Robinson R.K. (2002) Dairy Microbiology: Milk and Milk Products, 3rd Edn. Wiley Publishers.
4. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India
5. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd
6. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Ltd
7. Hammer B. W. and Babal, Dairy Bacteriology, Prentice Hall Incorporated
8. Jay J.M., Modern Food Microbiology, CBS Publishers and Distributors, New Delhi. India

### Dairy Microbiology Lab (BMI091A)

- 1) Sensory evaluation of milk
- 2) Chemical evaluation- Moisture, PR, HM, TVBN, Peroxide value, Acidity/ acid value
- 3) Detection of adulterants.
- 4) Enumeration of coliforms in milk.
- 5) Quantitative analysis of milk by SPC.
- 6) Enumeration of MPN in milk.
- 7) Enumeration of TPC in milk.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI092A	Food Law and Standards	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

- CO1 Understand the information relating to food laws and regulations.
- CO2 Understand the law making process as it applies to food and food technology.
- CO3 Understanding and interpreting information on food labels.
- CO4 Analyze the major food law legislation and its importance to current regulations.
- CO5 Analyze the role of regulatory agencies in enforcing current food laws.

### Unit I

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Introduction to food laws, prevention of food adulteration Act (PFA-1954). The preamble of act, definition, primary food, kinds of adulteration in the act, adulterated food, article held as court, misbranded food, functional responsibilities of various authority, central food laboratories, role of inspectors

### Unit II

Food safety and quality requirements. Voluntary requirement, legal requirement, mandatory provision prescribed under PFA Act 1954 and rule 1955. Enforcement of prevention of food adulteration act (PFA-1954) by state government, ministries, departments responsible for ensuring food safety and quality in India

### Unit III

Food safety and standards act 2006 (FSSA 2006) rules and regulations 2011, existing food law in India, salient features of FSSA 2016, important provision of FSSA, essential commodities act.

### Unit IV

Codex alimentarius commission(CAC) , Statutes of Codex alimentarius commission, need for harmonizing national standards with codex. WTO implication, SPS agreement, TBT agreement, relation between the codex and WTO.

### Unit V

Customs act and import control regulation, and other law related to food products, legal Metrology, provisions of weight and measures act 1976, the insecticides act 1968, Consumer Protection Act 1986, Customs Act 1962.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	1	3	3	1	2
CO2	3	2	2	1	1	2	1
CO3	3	1	3	3	2	1	2
CO4	3	1	3	2	1	2	2
CO5	2	2	1	2	2	1	1

3 = Highly Related; 2 = Medium; 1 = Low

### Food law and Standards Lab(BMI093A)

1. Case study of any food industry (food processing and packaging where laws applied)

#### Suggested Readings:

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1. Kiron Prabhakar(2016) A Practical Guide to Food Laws and Regulations. Bloomsbury india
2. Rajan Nijhawan (2016) Food Safety and Standards Act, 2006, Rules & Regulations-- ILBCO 22<sup>nd</sup> edition.
3. Virag gupta (2019) The food safety and standard act,2006 along with rules and regulations as amended upto 15 APRIL, 2019. 12<sup>th</sup> edition commercial law publishers. (India) Pvt. Ltd.
4. Adams M.R. and M.O. MOSS (2005). Food Microbiology. 1st edition. Reprinted. Published by New Age International (P) Limited. Publishers - New Delhi
5. Srilakshmi,B.,2005, Food Science., New Age International (P) Limited , New Delhi.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BM1094A	Microbial Toxins and Food Protection	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

- CO1 Understand the microbial toxins and contamination in food  
 CO2 Understand the food toxicity by various microbes and chemical sources.  
 CO3 Understand the general principle of food protection.  
 CO4. Understand the foods protection by physical methods.  
 CO5 Analyze the food additives role in various food

#### Unit I

Microbial toxins (endotoxin and exotoxin) and toxoids, source and chemistry of microbial toxins in contamination of food grains and food products.

#### Unit II

Food toxicology: classification, dose, determination toxins in food, naturally occurring toxins from animals, bacterial and fungal and sea food sources. Food additives as toxicants: artificial colors, preservatives, sweeteners; toxicants formed during food processing such as nitrosamines, maillard reaction products acrylamide, benzene, heterocyclic amines and aromatic hydrocarbons and irradiation, risk of genetically modified food, food supplements, persistent organic pollutants.

#### Unit III

General principles of food protection: methods of food protection, asepsis, maintenance of anaerobic conditions, protection by use of high temperature : Thermal death time, heat resistance

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of microorganisms, determination of thermal death process, protection by use of low temperatures: Growth of microorganisms at low temperatures, effect of subfreezing and freezing temperatures on microorganisms.

#### Unit IV

Protection by drying: methods of drying, factors in the control of drying, microbiology of dried foods, food protection with modified temperature: definition, primary effect of CO<sub>2</sub> on microorganism, the safety of Map foods, spoilage of Map and vacuum packaged meats.

#### Unit V

Protection by food additives: the ideal antimicrobial protection, food additives, added preservatives, developed preservatives, protection by Radiation: Ultra Violet radiation, ionizing radiations, Gamma rays and Cathode rays, Microwave processing.

#### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	2	0
CO2	2	2	0	1	2	1	1
CO3	3	1	2	1	1	2	1
CO4	2	2	1	0	0	1	2
CO5	3	3	2	1	0	2	1

3 = Highly Related; 2 = Medium; 1 = Low

#### Suggested Readings:

1. Introductory foods, Bennion M. and Hughes, D. (1975), Macmillan publishing Co., New York.
2. Food facts and principles, Sakuntala Manay and Shadaksaraswamy, M (1987) Allied Publishers, New Delhi.
3. Microbial Biotechnology by Glazer AN & Nikaido H., 2nd Ed., Cambridge University Press, 2007
4. Molecular Biotechnology by Glick BR, Pasternak JJ & Patten CL, Ed. IV, ASM Press, 2010
5. Biotechnology: A text Book of Industrial Microbiology by Crueger W, Crueger A, 2nd Ed., Sinauer associates, Inc.1990.

#### Microbial Toxins and Food Protection Lab (BMI095A)

- 1) Detection of microbes from spoiled meat, egg and fish.
- 2) Isolation and identification of *Salmonella*, *E. coli*, *Listeria*, *Proteus*, *Shigella* and *Vibrio* spp.
- 3) Isolation and identification of *Staphylococcus aureus* using Baird parker agar.
- 4) To determine the LD<sub>50</sub> value of common microbial toxin i.e. aflatoxin, enterotoxin.
- 5) To study the antibiotic sensitivity pattern and MIC for different food pathogen.

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- 6) To isolate and determine the food spoilage psychrotrophs from frozen food.
- 7) Biochemical characterization of purified bacterial strains for identification.
- 8) Microbial analysis from the chemically preserve food material.
- 9) Detection of microbial toxin from infected food/spoiled food.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI 096A	Introduction of Medical Microbiology	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

CO1-Remember the history and classification of pathogenic and medicinally important microorganisms.

CO2-Understand general characteristic, epidemiology, pathogenicity, diagnosis, prevention and control of Tuberculosis, Typhoid, Tetanus and Leprosy.

CO3- Understand the diseases such as flu, Mumps, Measles, Polio and Hepatitis B, Malaria and Leishmaniasis

CO4- Understand the sexually transmitted diseases (STD) and remember the generation of antibiotics and their mode of action on microorganism.

CO5- Understand the Transmission of pathogens including air borne, contact transmission and vector based transmission.

### Unit I

Discovery and History of pathogenic microorganism. Contribution made by eminent scientist's related to medical microbiology. Classification of medicinally important microorganism. Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract.

### Unit II

Characteristic of infectious disease. Disease cycle (source of disease, reservoir, carriers). Bacterial diseases, epidemiology, pathogenicity, laboratory, diagnosis, prevention and control of Tuberculosis, Typhoid, Tetanus and Leprosy.

### Unit III

General account of viral diseases; Pneumonia, flu, Mumps, Measles, Polio, Hepatitis B, Disease caused by Protozoan; malaria and leishmaniasis, amoebiasis.

### Unit IV

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Brief account of STD diseases. Antibiotic Ist, IInd, IIIrd and advanced antibiotics. Mode of action of antibiotic on microorganism (in brief).

### Unit V

General account of fungal diseases mycoses, subcutaneous. Transmission of pathogens (Air borne, contact transmission and vector transmission). control measures.

#### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	2	3	3	2	2
CO2	2	1	3	1	1	2	1
CO3	3	2	2	3	2	1	2
CO4	3	1	3	2	1	2	2
CO5	2	2	2	2	2	1	3

3= Highly Related; 2= Medium; 1 = Low

#### Suggested Readings:

1. Ananthanarayan R and Paniker CKJ, Textbook of Microbiology. 7<sup>th</sup> edition, 2005, University Press Publication.
2. Brooks GF, Carroll KC, Butel JS and Morse SA. Jawetz, Melnick and Adelberg's, Medical Microbiology, 24<sup>th</sup> edition, 2007, McGraw Hill Publication.
3. Goering R, Dockrell H, Zuckerman M and Wakelin D., Mims' Medical Microbiology. 4<sup>th</sup> edition, 2007, Elsevier.
4. Joklik WK, Willett HP and Zinsser ADB, Microbiology, 19<sup>th</sup> edition, 1995, Appleton-Century-Crofts publication.
5. Willey JM, Sherwood LM, and Woolverton CJ., Prescott, Harley and Klein's Microbiology, 7<sup>th</sup> edition, 2008, McGraw Hill Higher Education.

#### Introduction to Medical Microbiology Lab (BMI097A)

- 1) Direct examination of infected tissues (skin) for dermatophytes.
- 2) Isolation of microorganisms from wound infection.
- 3) Isolation of microorganisms from teeth crevices.
- 4) Examination of microorganisms of sputum.
- 5) Isolation of enteric pathogens (*Salmonella* and *Shigella*).
- 6) Estimation of urine bacteria by pour plate method.
- 7) Determination of antibiotic susceptibility of a given microorganism against various antibiotics.
- 8) Demonstration of various routes for drug delivery to humans.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI 010B	Immunology	4	1	4	2	5

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### Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the immune system and lymphoid organs.

CO2- Understand and apply to evaluate the structure, classes, interaction and function antigen and antibodies.

CO3- Understand the complementary pathway and structure, function of MHC.

CO4- Understand the auto-immune diseases.

CO5- Understand about types of vaccines, immunodeficiency and autoimmunity.

#### Unit I

Overview of immune system; innate immunity and adaptive immunity. Cells and Organs of immune system: lymphocytes, mononuclear phagocytes, granulocytic cells, primary and secondary lymphoid organs, mixed leucocytes culture (MLC)

#### Unit II

Antigens: Properties of antigens, Adjuvants, Haptens. Antibodies: Basic structure, classes and function, Polyclonal sera, Monoclonal antibodies, Antigen- Antibody interaction: precipitation reaction, agglutination reaction, neutralization reaction, lytic reaction and phagocytic reaction.

#### Unit III

Complement pathway (Classical and Alternative pathway), Major histocompatibility complex: class I & class II MHC antigens, antigen processing Structure and functions, organ transplant, transplantation immunology

#### Unit IV

Auto-immune diseases – autoimmunity & auto-immune diseases, factors contributing development of auto-immune diseases, mechanism of development, breakdown of self-tolerance, rejection of transplants, molecular mimicry, diagnosis & treatment of auto-immune diseases, replacement therapy, suppression of auto-immune processes, nature of auto-antigens, immunodeficiency, AIDS.

#### Unit V

Immune System in Health and Disease: Brief introduction to Vaccines, Immunodeficiency and autoimmune disorders, Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, tumor vaccines, principles of vaccination, passive & active immunization.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	1	1	0	1	1
CO2	2	2	1	1	0	1	2
CO3	2	2	2	1	0	1	1
CO4	3	3	3	2	3	2	0
CO5	3	2	3	3	2	2	0

3 = Highly Related; 2 = Medium; 1 = Low

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### Suggested Readings:

1. Abbas AK, Lichtman AH, Pillai S., Cellular and Molecular Immunology, 6<sup>th</sup> edition, 2007, Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM., Roitt's Essential Immunology, 11<sup>th</sup> edition, 2006, Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA., Kuby's Immunology, 6<sup>th</sup> edition, 2007, W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M., Janeway's Immunobiology, 7<sup>th</sup> edition, 2008, Garland Science Publishers, New York.
5. Peakman M, and Vergani D, Basic and Clinical Immunology, 2<sup>nd</sup> edition, 2009, Churchill Livingstone Publishers, Edinburgh.
6. Richard C and Geffrey S., Immunology. 6<sup>th</sup> edition, 2009, Wiley Blackwell Publication.

### Immunology Lab (BMI011B)

- 1) Demonstration of the bacterial flora of the skin.
- 2) Demonstration of dermatophytes.
- 3) Isolation of microbial flora of mouth (from saliva).
- 4) Isolation of microbes from upper respiratory tract (from throat).
- 5) Isolation of enteric pathogens (Coli form bacteria).
- 6) Determination of human blood group.
- 7) Determination of blood group along with Rh factor.
- 8) Demonstration of the Widal test.
- 9) Determination of RBCs in a given blood sample.
- 10) Estimation of WBCs count in a given sample.
- 11) Determination of differential leucocytes count (DLC) in given blood sample.
- 12) Determination of hemoglobin content in a given sample.
- 13) Determination of haematocrit (PCV) level of provided blood sample.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI098A	General Pathology	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

- CO1 Understand the general cell injury and adaptations.
- CO2 Understand the physiology of inflammation.
- CO3 Understand the Haemodynamic Disorders.
- CO4 Understand the collection of specimen.
- CO5 Understand the handling of the samples.

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## Unit I

Cell Injury and Cellular Adaptations. a) Normal Cell b) Cell Injury- types of cell injury, etiology of cell injury, morphology of cell injury, cellular swelling (in brief). c) Cell death: types- autolysis, necrosis, apoptosis & gangrene. d) Cellular adaptations-atrophy, hypertrophy, hyperplasia & dysplasia.

## Unit II

Inflammation a) Acute inflammation - vascular event, cellular event, inflammatory cells. b) Chronic Inflammation - general features, granulomatous inflammation, tuberculoma.

## Unit III

Haemodynamic Disorders : Oedema, hyperemia, congestion, haemorrhage, circulatory disturbances, thrombosis, ischaemia & infarction. Neoplasia: Definition, how does it differ from hyperplasia, difference between benign tumor and malignant tumor. Healing Definition, different phases of healing, factors influencing wound healing.

## Unit IV

Collection and Transportation of Specimen General Principles, Containers, Rejection, Samples-Urine, Faeces, Sputum, Pus, Body fluids, Swab, Blood.

## Unit V

Care and Handling of Laboratory Animals Fluid, Diet, Cleanliness, Cages, ventilation, Temperature, Humidity, handling of Animals, Prevention of disease. Disposal of Laboratory/Hospital Waste Non-infectious waste, Infected sharp waste disposal, infected non-sharp waste disposal.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	1	1	0	1	1
CO2	2	2	1	1	0	1	2
CO3	2	2	2	1	0	1	1
CO4	3	3	3	2	3	2	0
CO5	3	2	3	3	2	2	0

3= Highly Related; 2= Medium; 1 = Low

### Suggested Readings:

1. Murray PR, Baron EJ, Pfaller MA, Tenover PC and Tenover RH (Eds): Manual of Clinical Microbiology 6 th Ed. American Society for Microbiology, Washington, DC 2005.
2. Woods GL, Washington JA: The Clinician and the Microbiology Laboratory, Mandell

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Rajesh

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3. Ananthanarayan & Paniker's Textbook of Microbiology, 8th Ed., Orient Longman, India; 2009.
4. Bailey and Scott's Diagnostic Microbiology 9th Ed. C V Mosby, St. Louis, 2003.
5. Brooks, Geo F Jawetz Medical Microbiology 22nd Ed. Mc Graw Hill 2001.

#### General Pathology Lab (BMI099A)

- 1) Components and setting of the Compound microscope.
- 2) Focusing of object.
- 3) Use of low & high power objectives of microscope.
- 4) Use of oil immersion lens.
- 5) Care and Maintenance of the microscope.
- 6) Different types microscopy - • Dark field microscopy • Fluorescence Microscopy
- 7) Electronic Microscopy in brief.
- 8) Preparation of swabs/sterile tubes & bottles.
- 9) Preparation of smear.
- 10) Staining.: Gram & Ziehl -Neelsen staining.
- 11) Identification of Culture Media.
- 12) Identification of common microbes.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI100A	Clinical Biochemistry	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

- CO1 Analyze the spectroscopic techniques.  
 CO2 Understand the physiology of water and mineral metabolism  
 CO3 Understand the Renal Function Tests, electrophoresis, PCR, autoanalysers.  
 CO4 Analyze the cardiac profiling.  
 CO5 Analyze the biochemistry profiling of the macromolecules in the cell.

#### Unit I

Photometry Definition, laws of photometry, absorbance, transmittance, absorption maxima instruments, parts of photometer, types of photometry-colorimetry, spectrophotometry, flame photometry, fluuorometry, choice of appropriate filter, measurements of solution, calculation of formula, applications.

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## Unit II

Water & Mineral Metabolism Distribution of fluids in the body, ECF & ICF, water metabolism, dehydration, mineral metabolism, macronutrients (principal mineral elements) & trace elements. Liver Functions & their Assessment. Carbohydrate metabolism, Protein metabolism, Lipid metabolism, Measurements of serum enzyme levels 4-Bile pigment metabolism, Jaundice, its types and their biochemical findings.

## Unit III

Renal Function Tests- Various Tests, GFR & Clearance, Immunodiffusion Techniques, Radioimmunoassay & ELISA Principles & Applications. Electrophoresis - Principle, Types & Applications. Polymerase Chain Reaction - Principle & Applications, Autoanalysers - Principle & Applications

## Unit IV

Vitamins, Fat & water soluble vitamins, sources, requirement, deficiency disorders & biochemical functions. Cardiac Profile - In brief Hypertension, Angina, Myocardial Infarction, pattern of Cardiac Enzymes in heart diseases

## Unit V

Different methods of Glucose Estimation Principle advantage and disadvantage of different methods. Different methods of Cholesterol Estimation Principle, advantage and disadvantage of different methods.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	1	1	1	0	3
CO2	2	3	1	1	2	1	2
CO3	1	2	2	2	3	2	1
CO4	2	2	1	1	2	0	1
CO5	1	3	2	2	3	2	3

3= Highly Related; 2= Medium; 1 = Low

### Suggested Readings:

1. Murray PR, Baron EJ, Pfaller MA, Tenover PC and Tenover RH (Eds): Manual of Clinical Microbiology 6 th Ed. American Society for Microbiology, Washington, DC 2005.
2. Woods GL, Washington JA: The Clinician and the Microbiology Laboratory, Mandell
3. GL, Bennett JE, Dolin R (Eds): Principles and Practice of Infectious Disease 4th Ed. Churchill Livingstone, New York, 2002.

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4. E. Joan Stokes, M.W.D. Wren, G.L.Ridgway, Clinical Microbiology 7th Ed. Hodder Arnold Publishers 7 th Edition.
5. Ananthanarayan & Paniker's Textbook of Microbiology, 8th Ed., Orient Longsman, India; 2009.
6. Bailey and Scott's Diagnostic Microbiology 9th Ed. C V Mosby, St. Louis, 2003.
7. Brooks, Geo F Jawetz Medical Microbiology 22nd Ed. Mc Grew Hill 2001.
8. Collier, Leslie Topley and Wilson's Microbiology and microbial infections Vol 7; 9th Ed.

### Clinical Biochemistry lab (BMI101A)

- 1) Blood urea estimation
- 2) Serum creatinine estimation
- 3) Serum uric acid estimation
- 4) Serum total protein estimation
- 5) Serum albumin estimation
- 6) Serum globulin estimation
- 7) Serum glucose estimation
- 8) Total cholesterol estimation
- 9) HDL cholesterol (direct) estimation.
- 10) LDL cholesterol (direct) estimation
- 11) Triglyceride estimation
- 12) Serum Bilirubin total estimation
- 13) Serum Bilirubin direct estimation
- 14) Serum amylase estimation
- 15) Serum GOT (AST) estimation
- 16) Serum GPT (ALT) estimation
- 17) Alkaline phostase estimation
- 18) Acid phosphatase estimation
- 19) Serum sodium estimation
- 20) Serum potassium estimation
- 21) Serum chloride estimation

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI102A	Automation in Medical Microbiology	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

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- CO1 Understand the precipitation assay  
 CO2 Understand the physiology of inflammation.  
 CO3 Understand the Haemodynamic Disorders.  
 CO4 Understand the collection of specimen.  
 CO5 Understand the handling of the samples.

### Unit I

Automation - Introduction, meaning, advantages, history. Precipitation assays: Double diffusion method (Ouchterlony techniques), Counter immunoelectrophoresis, Radial immunodiffusion, Quantitative immunoelectrophoresis, Immunonephelometry, Immunoelectrophoresis, Immunofixation (immunoblotting), Western blot

### Unit II

Assay based on agglutination: Bacterial agglutination, Hemagglutination, Agglutination of inert particles coated with antigen or antibody.

### Unit III

Tests based on complement fixation. Test based on immunofluorescence, Immunofluorescence tests in microbiology, Quantitative immunofluorescence assay, Immunofluorescence tests for the detection of auto-antibodies, Immunofluorescence tests to detect tissue fixed antigen-antibody complex

### Unit IV

Flow cytometry-surface staining, cytoplasmic staining, DNA-analysis, sorting, Radio immunoassay, Enzyme immunoassay; Cell culture- primary, secondary and those using established cell lines.

### Unit V

Latest trends in Automation, Biochips, Lab on a chip (LoC), Nanosensors- advantages and disadvantages, PCR and its clinical applications.

#### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	3	2	3	3	1
CO2	1	3	3	3	2	1	2
CO3	2	2	2	2	3	0	1
CO4	3	2	3	0	2	1	2
CO5	1	3	2	2	3	3	1

3= Highly Related; 2= Medium; 1 = Low

#### Suggested Readings:

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*[Signature]*  
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1. Abbas AK, Lichtman AH, Pillai S., Cellular and Molecular Immunology, 6<sup>th</sup> edition, 2007, Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM., Roitt's Essential Immunology, 11<sup>th</sup> edition, 2006, Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA., Kuby's Immunology, 6<sup>th</sup> edition, 2007, W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M., Janeway's Immunobiology, 7<sup>th</sup> edition, 2008, Garland Science Publishers, New York.
5. Nakara and Choudhary, Instrumentation measurements and analysis, 3<sup>rd</sup> Edition , 2010, Tata Mc Graw Hill
6. Lodish, Berk, Matsudara, Kaiser, Krieger, Zipursky, Darnell, Molecular cell biology, 8<sup>th</sup> edition 2016, W.H. Freeman and Co.

#### Automation in Medical Microbiology Lab (BMI103A)

- 1) Various experiments using ELISA.
- 2) Demonstration of PCR.
- 3) Demonstration of Semi-Autoanalyzer or fully automated analyzer.
- 4) Dot ELISA.
- 5) Genotyping of candidate genes for diseases by RFLP.
- 6) Encapsulation of mammalian cells.
- 7) Isolation of cells from Chick embryo.
- 8) Establishment and maintenance of primary cell cultures.
- 9) Subculture of monolayer cells.
- 10) Subculture of suspension cells.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI104A	Human Anatomy and Physiology	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

- CO1 Understand the general anatomy of the various system of human.
- CO2 Understand the physiology of cardiovascular and gastrointestinal system.
- CO3 Understand the physiology of Endocrinology and urinary system.
- CO4 Understand the physiology of nervous system of human.
- CO5 Understand the physiology of skin, ear and nose.

#### Unit I

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General Anatomy a) Cell - structure & function b) Tissue - Epithelium - Connective - Sclerous - Muscular - Nervous c) Lymphatic System 2. Systemic Basic Features of : a) Cardiovascular system b) Respiratory system c) Digestive system d) Excretory system e) Genital (Male & Female) system f) Nervous system.

### Unit II

Cell: Structure & function. 2. Blood a) Blood cells b) Haemoglobin c) Blood groups d) Coagulation Factors e) Anaemia & Immunoglobulins 3. Cardiovascular system Heart rate, cardiac cycle, cardiac output, blood pressure, hypertension, radial pulse 4. Respiratory System a) Ventilation b) Functions c) Lungs Volumes and capacities 5. Gastrointestinal System Process of digestion in various parts.

### Unit III

Endocrinology a) List of Endocrine Glands b) Hormones: Their secretion and functions. Excretion system a) Structure of nephron b) Urine formation, Excretion system a) Structure of nephron b) Urine formation

### Unit IV

Central Nervous System a) Parts b) Sliding Filament Theory c) Neuro Muscular Junction d) Wallerian Degeneration e) Motor Nervous system - Upper motor neuron system - Lower motor neuron system f) Sensory nervous system g) Sympathetic Nervous system h) Parasympathetic nervous system

### Unit V

Skin - Function & Structure Muscular System, Classification of muscles & their functions, Special Senses - Eye & ear

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	0	1	1	2
CO2	2	2	1	1	0	2	1
CO3	3	3	2	1	1	1	2
CO4	2	2	1	0	0	1	3
CO5	2	3	2	0	0	2	1

3= Highly Related; 2= Medium; 1 = Low

### Suggested Readings:

1. Guyton. A. Text Book of Medical Physiology, Elsevier Publication
2. Ganong, W.F. Reviews of Medical Physiology Lange Publication
3. Khurana I, Text Book of Physiology
4. Berne V Principal of Physiology Elsevier Mosby Publication
5. Clinical Anatomy for Medical Students, by: Richard S. Snell
6. General Anatomy, by: Vishram Singh

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*Dr. Rishi*  
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7. General Anatomy, by: B.D.Chaurasia  
 8. Embryology for Medical Students, by: Inderbir Singh  
 9. Text Book of Histology, by: Inderbir Singh

### Human Anatomy and Physiology Labs (BMI105A)

Demonstration on the following:

- 1) Superior extremity: General features & identification of clavicle, scapula, humerus, radius, ulna, identification of the skeleton of hand.
- 2) Thorax: General features for thoracic vertebrae – typical and atypical, ribs-typical and atypical, sternum.
- 3) Inferior Extremity: General features of hip bone, femur, patella, tibia, fibula, identification of the skeleton foot.
- 4) Abdomen and Pelvis: General features of eleventh and twelfth ribs, lumbar vertebrae – typical and atypical, sacrum, coccyx, pelvis – male and female.
- 5) Brain: General feature of basis crania interna., skull cap.
- 6) Head and Neck: General features of skull, identification of individual skull bones, hyoid bone, ear ossicles, general features of cervical vertebrae typical and a typical.
- 7) Recording the arterial pulse.
- 8) Recording of Electrocardiogram.
- 9) Recording of human blood pressure.
- 10) To study the effect of change of posture on blood pressure.
- 11) To study the effect of moderate exercise on blood pressure.
- 12) Examination of Nervous system.
- 13) Examination of motor system.
- 14) To map peripheral field of vision with perimeter.
- 15) To find out acuity of vision.
- 16) To test colour vision.
- 17) To demonstrate light reflexes and accommodation reflex.
- 18) To assess the hearing of individual.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI106A	Parasitology	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

CO1 Understand the term parastism and parasites groups.

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- CO2 Understand the protozoan parasite infection in human.  
 CO3 Understand the malaria parasite infection  
 CO4. Understand the nematodes infection and diagnosis  
 CO5 Analyze the tissue invade nematodes infection and diagnosis

### Unit I

Definition - parasitism, HOST, Vectors etc. Classification of Parasites; Phylum Protozoa- general  
 Pathogenic and non pathogenic protozoa, Nematelminths/Round words (Nematoda),  
 Platyhelminths - class-Cestoda, class-Trematoda; Protozoa: Intestinal Amoebae; *Entamoeba histolytica*: Life cycle, Morphology, Disease & Lab Diagnosis.

### Unit II

Flagellates of intestine/genitalia: *Giardia lamblia* : Life cycle, Morphology, Disease & Lab  
 Diagnosis. *Trichomonas vaginalis* : Life cycle, Morphology, Disease & Lab Diagnosis; *E. coli* :  
 Life cycle, Morphology, Disease & Lab Diagnosis

### Unit III

Malarial Parasite: *Plasmodium vivax*: Life cycle, Morphology, disease & lab diagnosis;  
 Differences between *P. vivax*, *P. malaria*, *P. falciparum* & *P. ovale*.

### Unit IV

Nematodes: Intestinal Nematodes : *Ascaris* : Life cycle, Morphology, disease & lab diagnosis ;  
 Brief discussion about *Enterobius vermicularis* (Thread worm ) and *Ancylostoma duodenale*  
 (Hook worm)

### Unit V

Tissue Nematodes: *W. Bancrofti*- Life cycle, Morphology, Disease & Lab Diagnosis Phylum  
 Platyhelminths a. Cestodes - *T. solium*, *T. saginata* & *E. granulosus*. b. Trematodes - *S.*  
*haematobium* & *F. hepatica*.

#### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	1	2	2	2	0
CO2	2	1	1	1	2	0	1
CO3	2	1	2	1	1	2	1
CO4	2	2	1	0	0	1	1
CO5	1	2	3	1	2	1	1

Suggested Readings:

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1. Medical Mycology. Kwon-Chung K.J and Bennett JE. 1992. Lea and Febiger, Philadelphia, USA.
2. Bailey and Scott's Diagnostic Microbiology- 11th edition: Eds: Forbes BA, Sahm DF, Weissfeld AS. 2002, Mosby, St. Louis, USA.
3. Medical Microbiology, 3rd edition. Eds: MIMS and others. 2004 Mosby, Spain.
4. Topley & Wilson's Microbiology and Microbial infections. 10th edition. Volumes 1- 6: 2008 Arnold, London.
5. Medical Parasitology. Rajesh Karyakarte & Ajit Damle, Books & Allied (P) Ltd., 2003.
6. Medical Immunology, 9th edition Eds: Stites DP, Terr AI and Parslow TG.1997, Appleton & Lange, Stamford, USA

#### Parasitology Lab (BM1107A)

- 1) Stool examination.
- 2) Identification of different ova & cysts in stool samples.
- 3) Examination of blood films including Leishmans stain for malarial parasites.
- 4) Lab diagnosis of parasitic infections.
- 5) Examination of Bone marrow smears for LD bodies
- 6) Examination of Hydatid fluid for scolices, hydatid hooklets.
- 7) Examination of CSF for *Acanthamoeba*
- 8) Examination of Liver abcess fluid for *Entamoeba*.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BM1108A	Basic Industrial Microbiology	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the introduction to industrial microbiology and fermentation processes.

CO2- Understand the types of bioreactors and measurement of fermentation parameters.

CO3- Understand and apply industrially microbial strains and fermentation media.

CO4- Understand and apply the down-stream processing.

CO5- Understand and apply industrially relevant products derived from Microbes.

#### Unit I

Brief history and developments in industrial microbiology, Types of fermentation processes: Solid-state and liquid-state (stationary and submerged) fermentations, Batch, fed-batch and

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continuous fermentations.

## Unit II

Components of a typical bioreactor. Types of bioreactors: Laboratory, pilot-scale and production fermenters, continuously stirred tank reactor, air-lift fermenter. Measurement and control of fermentation parameters: pH, temperature, dissolved oxygen, foaming and aeration.

## Unit III

Industrially important microbes and their isolation, preservation and maintenance methods. Crude and synthetic media: Molasses, corn-steep liquor, sulphite waste liquor, whey, yeast extract, soybean meal, peptone and tryptone.

## Unit IV

Cell disruption by physical, chemical and biological methods. Membrane filtration, ultrafiltration, centrifugation, solvent-solvent extraction, precipitation, lyophilization and spray drying. Production of fermented beverages, alcohol, wine, beer, ethanol.

## Unit V

Microorganisms, fermentation and recovery strategies: citric acid, glutamic acid, Vitamins - riboflavin, cyanocobalamin. Antibiotics: Penicillin, streptomycin. Enzymes: amylase, protease, lipase. Vaccines - genetic recombinant vaccines. Enzyme immobilization (cross linking, entrapment, adsorption and covalent bonding) and its applications.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	3	3	2	2
CO2	2	1	2	1	1	2	1
CO3	3	2	1	2	3	3	2
CO4	2	3	2	3	2	2	3
CO5	2	1	3	1	1	1	1

3= Highly Related; 2 = Medium; 1 = Low

### Suggested Readings:

1. Okafor N. and Okeke B.C., Modern Industrial Microbiology and Biotechnology, 2nd edition. CRC press, UK. 2017.
2. Crueger W., Crueger A. and Aneja K.R., Biotechnology: A Textbook of Industrial Microbiology by. 3rd edition. Medtech Publisher, India. 2017.
3. Clark W., Biotechnology: Industrial Microbiology. CBS Publishers, India. 2016.
4. Peppler H.J. and Perlman D., Microbial technology. Vol I- Microbial processes and Vol II - Fermentation technology, 2nd edition. Academic Press, USA. 2009.
5. Stanbury P.F., Whitaker A. and Hall S.J., Principles of Fermentation Technology 2nd edition. Elsevier Science Ltd, Netherlands. 2006.

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6. Waites M.J., Morgan N.L, Rockey J.S. and Highton G., Industrial Microbiology: An Introduction by Wiley –Blackwell. 2001.
7. Patel A.H., Industrial Microbiology ,1st edition. Macmillan India Limited.1996.
8. Glazer A.N. and Nikaido H., Microbial Biotechnology: Fundamentals of Applied Microbiology ,1st edition. W.H. Freeman and Company, UK.1995.
9. Casida L.E., Industrial Microbiology by. 1st edition. Wiley Eastern Limited, USA. 1991.

### Basic Industrial Microbiology Lab (BM1109A)

- 1) Screening for amylase producing microorganisms.
- 2) Screening for organic acid producing microorganisms.
- 3) Microbial production and estimation of enzymes: Protease/Lipase
- 4) Microbial Production and estimation of Ethanol.
- 5) Production and Estimation of Citric acid.
- 6) Estimation of streptomycin.
- 7) A visit to any educational institute/industry to see different parts of an industrial fermenter and downstream processing techniques.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BM1110A	Fermentation Technology	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

- CO1- Understand the basic of fermentation technology and apply this knowledge to isolate the industrial important microorganism.
- CO2- Understand the significance of industrial Microorganisms and various media sterilization technique used in fermentation.
- CO3- Understand the basic of fermentor system and types of cell reactors.
- CO4- Understand the basic of fermentor design and its various types.
- CO5- Understand the scale up study, product recovery and down-stream processing, product development.

### UNIT-I

History and Scope of fermentation technology. Industrial Microorganisms: Desirable characteristics and selection of industrial Microorganism, Isolation of suitable industrial microorganisms from natural habitat, Culture Collection Centres, Strain improvement and maintenance.

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## UNIT-II

Biology of industrial Microorganisms: Cell growth, Microbial growth kinetics, factors affecting growth, Basic nutrition, Primary metabolism, Secondary Metabolism, Regulation of Metabolism. Fermentation Media: Media composition, Media sterilization, Contamination, Inoculum media, Media economics, Screening for fermentation media

## UNIT-III

Fermentation system: Batch and continuous fermentation system, immobilized cell reactor system, solid state fermentation reactors.

## UNIT-IV

Fermentor design: Basic design of Fermentor, Construction of bioreactors,, Requirements of aseptic operation, Aeration and mixing, Type of Fermentors stirrer tank bubble column and airlift, Instrumentation and control.

## UNIT-V

Scale up study: Product recovery, scale up of fermentation, Down-stream processing, Product development, Regulation and safety

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	2	1	1
CO2	2	2	2	1	1	2	2
CO3	3	3	3	2	2	1	1
CO4	3	2	3	1	1	2	1
CO5	2	2	2	1	1	2	2

3= Highly Related; 2 = Medium; 1 = Low

### Suggested Readings:

1. Aneja.K.R et al.: A Text book of Basic and Applied Microbiology, New Age International Publishers, New Delhi.
2. Aneja.K.R and Mehrotra R.S.: Fungal Diversity & Biotechnology, New Age International Publishers, New Delhi.
3. Waites M.J. et al.: Industrial Microbiology, Blackwell Science Ltd.
4. Casida L.E.: Industrial Microbiology, New Age International Publishers, New Delhi.
5. Prescott and Dunn's.: Industrial Microbiology, AVI Publishing Co. USA.
6. Glazer A.N and Nikaido, H.: Microbial Biotechnology, W.N. Freeman and Co

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## Fermentation Technology Lab (BMI111A)

- 1) Determination of oil and grease from industrial waste.
- 2) Estimation of TS, TSS and TDS from sewage and industrial effluent.
- 3) Estimation of TVS from sewage and industrial effluent
- 4) Bacteriological analysis of potable water MPN
- 5) Estimation of chlorine dose of potable water
- 6) Production of penicillin in the laboratory.
- 7) Primary screening of amylase producing bacteria from soil.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI112A	Microbial Production of Metabolites	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the basic of nucleic acid production on large scale.

CO2- Understand the microbial production of necessary vitamins through fermentations technique.

CO3- Understand the microbial production of antibiotics, organism used production process and recovery of bacitracin.

CO4- Understand the taxonomical classification of bacterial biofertilizers and their physiology.

CO5- Understand the production of biofertilizers along with culture production, storage, and transportation technique.

### UNIT – I

Microbial production of nucleosides and nucleotides: i) Introduction ii) Classification of methods for production of 5' IMP and 5' GMP iii) Production of 5'IMP and 5'GMP by fermentation.

### UNIT – II

Microbial production of Vitamins: 1) Vitamin B12 - Organisms used, production method-process, recovery and assay. 2) Vitamin C - Organisms used, production method, process, recovery and assay.

### UNIT – III

Microbial Production of Antibiotics: Organism used, production process and recovery of-Bacitracin & Chloramphenicol, Production of Bioinsecticides: Introduction, Candidate Microorganisms, Production, Safety, Effectiveness, Advantages and Disadvantages

### UNIT – IV

Bacterial Biofertilizers: Taxonomy, physiology and mass cultivation of *Rhizobium*, *Frankia*, *Azospirillum*, *Azotobacter* and *Cyanobacteria*

### UNIT – V

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Production of Biofertilizers: Isolation and identification of different nitrogen fixing microbes, assessment of nitrogen fixing ability of different strains under controlled and field conditions. Direct and indirect methods, culture production, storage, culture, carrier.

# MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	2	2	0
CO2	3	2	2	1	1	1	2
CO3	2	1	1	2	2	2	1
CO4	3	2	3	1	1	1	1
CO5	2	2	1	2	2	2	0

3= Highly Related; 2 = Medium; 1 = Low

## Suggested Readings:

- Alexander, M. Introduction to Soil Microbiology; Wiley, New York.
- Sperut and Spemt: Nitrogen Fixation
- Aneja et al.: A Text book of Basic and Applied Microbiology, New Age International Publishers, New Delhi.

## Microbial Production of Metabolites Lab (BMI113A)

- 1) Production of wine from grapes in the laboratory.
- 2) Demonstration of mushroom production (White button mushroom).
- 3) Isolation of Azotobacter from soil.
- 4) Isolation of Rhizobium from legume root nodules.
- 5) Preparation of biofertilizer from Azotobacter and Rhizobium in the laboratory.
- 6) Culturing and identification of yeast (Saccharomyces cerevisiae) in the lab.
- 7) Demonstration of amylolytic activity by a mold/bacterium.
- 8) Demonstration of proteolytic activity by a mold/bacterium.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI114A	Quality Assurance and Quality Control of Microbial Products	4	1	4	2	5

## Course outcome (CO)

On completion of the course, students are able to:

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- CO1- Understand the basic industrial Rules and standards as per IP, BP, USP, PFA and remember the laws of Indian pharmacopoeia.  
 CO2- Understand the detection technique of compounds and apply the knowledge to detect the compounds using indian pharmacopoeia.  
 CO3- Understand and apply the knowledge of quality control tests of pharmaceutical products.  
 CO4- Understand and remember the international standards as per WHO, ISI, Biosafety and Validation.  
 CO5- Understand the biosafety in laboratories and pharmaceutical industries, environmental monitoring and bioburden tests.

### UNIT - I

Industrial Rules and standards as per IP, BP, USP, PFA, Indian Pharmacopoeia: i) Introduction ii) Concept of pharmacopoeia iii) Concept of regulatory authorities iv) Types of pharmaceutical products iv) Microbiological Q.C

### UNIT - II

Detection of Compounds using Indian Pharmacopoeia: A. Detection of Ascorbic acid tablets B. Detection of Vit. B12 C. Detection of Antibiotics - penicillin and streptomycin

### UNIT - III

Quality Control Tests of Pharmaceutical Products i) Sterility test ii) Pyrogen test iii) Toxicity test iv) Carcinogenicity test iv) Mutagenicity test v) Allergy test

### UNIT - IV

International Standards as per WHO, ISI, Biosafety and Validation A) Introduction of WHO, ISI standards. B) Concept of validation.-validation of moist heat sterilization in pharmaceuticals

### UNIT - V

Biosafety in Laboratories and Pharmaceutical Industries, Environmental Monitoring and Bioburden Tests

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	1	3	2	3	1	1
CO2	2	2	2	1	1	2	2
CO3	1	3	3	2	3	1	1
CO4	3	1	1	1	1	1	2
CO5	2	2	3	2	3	2	1

3= Highly Related; 2 = Medium; 1 = Low

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### Suggested Readings:

1. Aneja.K.R et al.: A Text book of Basic and Applied Microbiology, New Age International Publishers, New Delhi.
2. Aneja.K.R and Mehrotra R.S.: Fungal Diversity & Biotechnology, New Age International Publishers, New Delhi.
3. Waites M.J. et al.: Industrial Microbiology, Blackwell Science Ltd.
4. Casida L.E.: Industrial Microbiology, New Age International Publishers, New Delhi.

### Quality Assurance and Quality Control of Microbial Products Lab (BMI115A)

- 1) Determination of pH
- 2) Determination of Acidity
- 3) Determination of alkalinity
- 4) Determination of moisture content
- 5) Determination of Chlorine dosage
- 6) Examine the Microbial limit test of tablet/capsule
- 7) Determination of sterility test of pharmaceutical products.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI116A	Industrial Management, Government Laws and Regulations	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

- CO1- Understand the basic principles of management, management meaning and concept of entrepreneurship
- CO2- Understand the concepts of management and process of organization.
- CO3- Understand the national and international scenario of patent, biopatent, copyright, trade secret, trademark and geographical Indications.
- CO4- Understand the laws related to industrial regulation, industrial development and industrial regulation act.
- CO5- Understand the basic laws related to industrial regulation taxation: Basic concept of taxation.

### UNIT – I

Entrepreneurship - Principles of management, management meaning and importance, Concept of Entrepreneurship

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## UNIT – II

Concepts of Management: i. Planning meaning and importance ii. Organizing - Meaning and process of organization iii. Communication – Meaning and process control techniques. iv. Personal Management – Man power planning v. Purchase and store management – Concept of quotation, tenders, comparative statement, inspection and quality control, store management. vi. Concept of marketing – Basic Concepts, Costing, Pricing vii. Financial management – Fund raising, costing and pricing

## UNIT – III

IPR, National and International Scenario:-Patent, Biopatent, Copyright, Trade secret, Trademark, Geographical Indications, Designs, its basic concepts and laws relating to its infringement -IPR and WIPO, TRIPS

## UNIT – IV

Laws related to industrial regulation: Industrial development and regulation act- Object - Licensing of industries -Circumstances when license not required

## UNIT – V

Laws related to industrial regulation taxation: Basic concept of taxation - -Principle of taxation - Direct and indirect tax -Excise, sales MVAT

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	1	2	1	2	2
CO2	1	2	3	1	1	2	2
CO3	2	3	3	2	2	1	3
CO4	1	1	2	2	1	2	2
CO5	2	2	2	3	2	2	3

3= Highly Related; 2 = Medium; 1 = Low

### Industrial management, Government Laws and Regulations Lab (BMI117A)

1. Case study of any local industry (Management, Process and laws applied)

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI118A	Biomining and Microbial Metabolites	4	1	4	2	5

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### Course outcome (CO)

On completion of the course, students are able to:

- CO 1 Understand the basic concepts of Microbial extraction of metals from minerals and aqueous effluents.
- CO 2 Understand the Concept of enzymology, classification, and largescale isolation methods using fermentation technology and their application.
- CO 3 Understand the Concept of biosurfactants, types and their applications.
- CO 4 Understand the Enzymes – production and applications of other enzymes.
- CO 5 Understand the biosurfactants, definition, classification, types and their application in environment.

### Unit I

Microorganisms in mineral recovery, indirect leaching and direct leaching, microorganisms involved in oxidation of minerals, recovery of copper by dump leaching, uranium leaching, gold mining, microorganisms in the removal of heavy metals from aqueous effluents

### Unit II

Broad classification of Enzymes, Production of microbial enzymes (Strain selection and development, fermentation process and composition of the medium), large scale applications of microbial enzymes-Enzymes for starch processing, use of genetically modified *Bacillus* strain for production of amylases.

### Unit III

Enzymes for textile designing (Subtilisins, genetic engineering of subtilisins), Enzymes for Cheese making (Chymosin-action, properties and recombinant chymosin. Lipases-properties and applications (interesterification of fats and oils).

### Unit IV

Enzymes – production and applications of other enzymes such as invertase, pectinase, cellulase, glucose oxidase, catalase, lactase, polymerase, glucose isomerase etc.

### Unit V

Biosurfactants, definition, classification, types and their application in environment, petroleum recovery and other fields Microbial pigments-source, production and application, Biotransformation of steroids and antibiotics.

### Biomining and Microbial Metabolites Lab (BMI119A)

- 1) Isolation and Identification of Reserve food material (Glycogen / polyphosphates, PHB) of *B. megaterium* and *Azotobacter* sp.
- 2) Quantitative estimation of amino acids by Rosen's method.
- 3) Quantitative estimation of sugars by Summner's method.

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- 4) Demonstration of endogenous metabolism in *B megaterium* or *E. coli* and their survival under starvation conditions
- 5) Quantitative estimation of proteins by Folin-Lowry / Biuret method.
- 6) Production of fungal alpha amylase using solid-state fermentation/ production of protease by bacterial species and confirmation by determining the achromic point.
- 7) Purification of fungal alpha-amylase or bacterial protease by fractionation.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	2	2	0	2	3	2
CO2	2	3	2	1	2	2	3
CO3	3	1	1	0	1	1	2
CO4	1	2	1	0	1	1	3
CO5	3	2	1	1	2	1	2

**Suggested Readings:**

1. Microbial Biotechnology by Glazer AN & Nikaido H., 2nd Ed., Cambridge University Press, 2007
2. Molecular Biotechnology by Glick BR, Pasternak JJ & Patten CL, Ed. IV, ASM Press, 2010
3. Biotechnology: A text Book of Industrial Microbiology by Crueger W, Crueger A, 2nd Ed., Sinauer associates, Inc, 1990.
4. Encyclopedia of Environmental Microbiology, 6 Vol. Set. Willey Publication.
5. Microbial Ecology by Alexander. Willey Publication

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI120A	Microbial Products for Human Consumption	4	1	4	2	5

Course outcome (CO)

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On completion of the course, students are able to:

- CO 1 Understand the basic Antibiotics types, range and production of different types of antibiotics.
- CO 2 Understanding of immune system and development and production of various kinds of vaccines, vitamins and proteins.
- CO 3 Understand the Use of microbes in various fermented food products for human consumption.
- CO 4 Understand the use of microbes in the production of alcoholic bevarages.
- CO 5 Understand the production of Whiskeys – types and wine

### Unit I

Antibiotic fermentations – production of  $\beta$  lactams (penicillins), semi-synthetic penicillins and cephalosporins, amino-glycosides (streptomycin), macrolids (Erythromycin), quinines.

### Unit II

Production of proteins in bacteria and Yeast (Chymosin production) Recombinant and synthetic vaccines (problems with traditional vaccines, impact of Biotechnology on vaccine development- Subunit vaccine for Hepatitis B, potential problem of subunit vaccines). Vitamins (B12, riboflavin A)

### Unit III

Microbes in food industry, fermented foods (breads, sauerkraut, pickles, soysauce, tofu, tempeh, natto and poi) Dairy products from microbes (cheese, curd, yoghurt), microbes as food - single cell protein, mushrooms, probiotics.

### Unit IV

Alcoholic beverages – brief history of development of industrial process, production of beer (brewing) – media (raw materials used), process, maturation, carbonation. Types of beer (lager, pilsner, bock, ale, stout, porter).

### Unit V

Whiskeys – types and production, Production of wine –media and raw material used, different types (sparkling wine, burned wine, cider, wine vinegar), vinegar.

### Microbial Products for Human Consumption Lab (BMI121A)

- 1) Demonstration of antibiotic fermentation through batch fermentation.
- 2) Demonstration of process of penicillin production through fermentation.
- 3) Isolation and identification of chymosin producing bacteria.
- 4) Demonstration of the role of recombinant and synthetic vaccines developed for human's.

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- 5) To produce fermented food sauerkraut.
- 6) Study of single cell protein and its production process.
- 7) Production of wine from grapes.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	2	1	2	3	1
CO2	2	2	2	0	3	1	1
CO3	3	3	2	1	1	2	2
CO4	2	1	2	2	2	2	3
CO5	2	1	3	1	1	1	1

**Suggested Readings:**

1. Palmer T. (2001) Enzymes Biochemistry, Biotechnology and Clinical Chemistry, 5th Edition, Howood Publishing Chishester, England.
2. Marangoni A.G. (2003), Enzyme Kinetics-A Modern Approach.
3. Price N.C. and Stevens L. (1999), Fundamentals of Enzymology 3rd Edition Oxford University Press, New York.
4. Dixon M. and Webb E.C. (1979), Enzyme, 3rd Edition, Academic Press, New York.
5. Uhlig H (1998), Industrial Enzymes and Their Applications, Jone Wiley, New York.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI122A	Environment and Microorganisms	4	1	4	2	5

**Course outcome (CO)**

On completion of the course, students are able to:

- CO1- Understand the scope and importance of environmental microbiology.  
 CO2- Understand and apply the aeromicrobiology.  
 CO3- Understand the biogeochemical cycles and microbial transport.  
 CO4- Understand and apply the microbial interactions.

*Wae* *hss* *Prof. Dr. Renu Renu* *Rashmi*

CO5- Understand and apply solid waste management.

### Unit I

Introduction to environmental microbiology, scope and importance. Microorganisms in environment: viruses, bacteria, algae, fungi and protozoa. Terrestrial environment: soil and soil subsurface environment, microorganisms in surface soil, shallow and deep subsurface environment.

### Unit II

Aeromicrobiology : atmosphere, aeromicrobiological pathway, microbial survival in air, extramural and intramural aeromicrobiology. Aquatic and extreme environments: microbes present in aquatic environment, environment determinants that govern extreme environments.

### Unit III

Microbial transport: factors affecting microbial transport, factors affecting transport of DNA. Biogeochemical cycling: carbon cycle: Microbial degradation of cellulose, nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate, sulfur cycle: Microbes involved in sulphur cycle; Phosphorus cycle.

### Unit IV

Microbial interactions: Microbe-microbe interactions: mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-plant interactions: microbes associated with roots and aerial plant surfaces, *Rhizobium* symbiosis, *Anabaena-Azolla* symbiosis, mycorrhizal associations, actinorhizal associations.

### Unit -V

Solid waste management: Sources and types of solid waste, methods of solid waste disposal: incineration, sanitary landfill, composting.

### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	3	1	1
CO2	2	1	2	1	2	2	1
CO3	3	1	1	2	3	3	2
CO4	2	3	2	2	2	1	3
CO5	2	1	3	1	1	1	1

3 = Highly Related; 2 = Medium; 1 = Low

### Suggested readings:

1. Atlas RM and Bartha R., Microbial Ecology: Fundamentals & Applications. 4<sup>th</sup> edition, 2000, Benjamin/Cummings Science Publishing, USA.
2. Atlas RM., Microbiology: Fundamentals and Applications. 2<sup>nd</sup> Edition, 1989, MacMillan Publishing Company, New York.
3. Madigan MT, Martinko JM and Parker J., Brock Biology of Microorganisms. 12<sup>th</sup> edition, 2009, Pearson/ Benjamin Cummings.

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4. Lynch JM & Hobbie JE., Microorganisms in Action: Concepts & Application in Microbial Ecology, 1988, Blackwell Scientific Publication, U.K.
5. Maier RM, Pepper IL and Gerba CP., Environmental Microbiology. 2<sup>nd</sup> edition, 2009, Academic Press.

### Environment and Microorganisms Lab (BMI123A)

- 1) Isolation of microbes from soil samples.
- 2) Isolation of microbes from water samples.
- 3) Isolation of microbes from air.
- 4) Determination of dissolved oxygen (DO) of water samples.
- 5) Determination of biological oxygen demand (BOD) of water samples.
- 6) Determination of chemical oxygen demand (COD) of water samples.
- 7) Bacteriological examination of water by multiple tube fermentation test (multiple tube test)
  - (a) Presumptive coli form test, (b) Confirmed coli form test, and (c) Completed coli form test.
- 8) Isolation of *Rhizobium* from root nodule.
- 9) Demonstration of ammonification.
- 10) Demonstration of nitrification.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI124A	Eco-Restoration and Development	4	1	4	2	5

### Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the basic concept of land degradation and apply the knowledge to degraded lands conservation.

CO2- Understand the necessity of soil conservation and role of microbes in improvement of soil fertility.

CO3- Understand the basic concept of green environment techniques and apply the knowledge to production of eco development and environmental friendly products.

CO4- Understand the PGPR bacteria and their role in eco friendly environment and bio-control of plant pathogen.

CO5- Understand the Microbial transformation, accumulation and concentration of metals, metal leaching, extraction, exploitation of microbes in copper and uranium extraction

### Unit -I

Degraded lands: agricultural practices and land degradation, Mining and its impact on soil quality Conservation of degraded lands, Rehabilitation of mine soils and salt affected soils.

### Unit -II

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Soil Conservation: Biological reclamation techniques Bio fertilizers, microrrhizae, Vermi composting, afforestation, Organic farming, Bio remediation.

### Unit -III

Approaches for environmental awareness and education, Eco development and environmental friendly products and technologies. Green environment techniques.

### Unit -IV

PGPR bacteria: biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology.

### Unit -V

Microbial transformation, accumulation and concentration of metals, metal leaching, extraction; exploitation of microbes in copper and uranium extraction, use of bioreactors for bioremediation.

#### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	2	1	3	3	3	3
CO2	3	3	2	2	2	2	3
CO3	1	3	1	2	2	2	2
CO4	3	2	1	3	1	1	2
CO5	2	2	2	2	1	2	3

3= Highly Related; 2= Medium; 1 = Low

#### Suggested Readings:

1. Tyler Miller Jr. G. 1990. Living in the Environment. Wadsworth Publishing Company, Belmont California.
2. Cunningham. W.P., 1994, Understanding Our Environmental : An Introduction W.C. Brown Publishers, Oxford.
3. Singh J.S., 1993, Restoration of degraded lands, Rastogi Publications, Meerut.
4. Singh J.S., Singh S.P. and Gupta S.R., 2006, Ecology Environment and Resource Conservation, Anamaya Publishers, New Delhi.

#### Eco-Restoration and Development Lab (BMI125A)

- 1) Bacteriological examination of water by multiple tube fermentation test
- 2) Isolation of *Rhizobium* from root nodule.

*Widaw* *7/8/21* *Devesh* *Ravi* *Rashmi*

- 3) Demonstration of ammonification.
- 4) Demonstration of nitrification.
- 5) Analysis of pesticides residues using TLC
- 6) Demonstration of soil conservation techniques
- 7) Demonstration of water conservation techniques
- 8) Demonstration of Biogas plant

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI126A	Environmental Monitoring	4	1	4	2	5

#### Course outcome (CO)

On completion of the course, students are able to:

- CO1- Understand the basic concept of environmental monitoring and apply the knowledge to monitor the different aspect of environment.
- CO2- Understand the sampling process for air monitoring and devices used for the air monitoring.
- CO3- Understand the basic concept of water quality monitoring and physical and chemicals characteristics of water.
- CO4- Understand the biological aspects of environment monitoring and bio indicators used for environmental monitoring
- CO5- Understand the EIA – Aims, objectives and methods and Geographical Information System Remote sensing and application in environment

#### Unit -I

Environment monitoring : Concept, aims, measurement and data collection on Meteorological parameters – solar radiation, temperature Humidity, precipitation, wind direction and speed. Plume behaviour, wind rose – a brief idea.

#### Unit -II

Chemical aspect of air quality monitoring : sampling of gaseous and suspended particulate matter ; basic considerations, devices and methods used : absorption, adsorption, condensation, sedimentation, filtration, Impingement, electrostatic precipitation, centrifugal methods.

#### Unit -III

Water quality monitoring : water quality parameters, Physical and chemicals characteristics of water : Colour, turbidity, odour and taste, total solids, conductivity, pH, acidity, alkalinity, hardness, Dissolved Oxygen, Biological Oxygen Demand and Chemical Oxygen demand

#### Unit -IV

Biological aspects of Environment Monitoring: Bio indicators of environmental monitoring Microbiological quality of water Bio indicators of water quality Vegetation monitoring – a brief idea.

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### Unit -V

EIA - Aims, objectives and methods EIA case studies river valley, projects and thermal power plants Geographical Information System Remote sensing and application in environment

#### MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	3	2	3	3
CO2	3	1	2	2	3	3	2
CO3	3	3	3	3	3	2	2
CO4	2	2	2	1	2	3	3
CO5	2	3	2	2	3	2	2

3= Highly Related; 2= Medium; 1= Low

#### Suggested Readings:

1. Khopkar, S.M. 1993 : Environmental Pollution Analysis, Wiley Eastern Limited New York
2. Rao M.N. and H.V.N. Rao, 1989 : Air Pollution, Tata McGraw Hill Publishing Co. Ltd., New Delhi
3. Wild A., 1993 : Soils and the Environment, Cambridge University Press, Cambridge.
4. Tyler Miller Jr. G. 1990. Living in the Environment. Wadsworth Publishing Company, Belmont California.
5. Botkin, D.B and Keller E.A., 1982: Environmental Studies : The earth as a living plant. Charles E. Merrill, Publishing Co. London.

#### Environmental Monitoring Lab (BMI127A)

1. Determination of dissolved oxygen (DO) of water samples.
2. Determination of biological oxygen demand (BOD) of water samples.
3. Determination of chemical oxygen demand (COD) of water samples.
4. Determination of Conductivity in drinking water sample
5. Determination of turbidity in drinking water sample
6. To determine the concentration of iron in water sample by spectrophotometric method
7. Evaluation of Disinfectant - Phenol co-efficient test

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI048A	Waste Management	4	1	4	2	5

#### Course outcome (CO)

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On completion of the course, students are able to:

CO1- Understand the municipal solid waste, its sources and types of solid waste- composition and its determinants apply the knowledge for sampling methods of solid waste.

CO2- Understand the collection and transfer of solid waste.

CO3- Understand the basic concept of processing techniques and recovery of energy from solid waste.

CO4- Understand the various techniques used for disposal of solid waste including incineration and land filling.

CO5- Understand the basic of biomedical waste and chemical waste and their harmful effect on human.

### Unit - I

Municipal solid waste Definition - Sources and types of solid waste- composition and its determinants of Solid waste-factors influencing generation-quantity assessment of solid wastes- methods of sampling and characterization.

### Unit - II

Collection and Transfer Collection: Collection of Solid waste – collection services – collection system, equipments – time and frequency of collection – labour requirement – factors affecting collection – analysis of collection system – collection routes – preparation of master schedules.

### Unit-III

Processing Techniques and Recovery of Energy Processing techniques – purposes mechanical volume reduction – necessary equipments – chemical volume reduction – incinerators – mechanical size reduction selection of equipments – components separation – methods – drying and dewatering.

### Unit - IV

Disposal of Solid Wastes Refuse disposal – various methods – incinerations – principle features of an incinerator – site selection and plant layout of an incinerator - sanitary landfill- methods of operation – advantages and disadvantages of sanitary land fill - site selection – reactions accruing in completed landfills– gas and leachate movement and control – equipments necessary.

### Unit V

Biomedical and chemical wastes Biomedical wastes – Types – Management and handling – control of biomedical wastes Chemical wastes – Sources – Domestic and Industrial -Inorganic pollutants – Environmental effects – Need for control – Treatment and disposal techniques – Physical, chemical and biological processes – Health and environmental effects

# MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	1	1	2
CO2	2	2	1	1	2	1	1
CO3	2	2	2	2	2	2	1
CO4	2	2	1	2	3	1	1
CO5	3	1	1	1	2	2	2

3= Highly Related; 2= Medium; 1 = Low

## Suggested Reading:

- George Tchobanoglous et al, "Integrated Solid Waste Management" McGraw - Hill, 1993. Tchobanoglous Thiesen Ellasen; Solid Waste Engineering Principles and Management, McGraw - Hill 1997.
- R.E.Landrefh and P.A.Rebers, "Municipal Solid Wastes-Problems & Solutions", Lewis, 1997.
- Manual on Municipal Solid waste Management, CPHEEO, Ministry of Urban Development, Govt. Of. India, New Delhi, 2000.
- Blide A.D.& Sundaresan, B.B, "Solid Waste Management in Developing Countries", INSDOC, 1993.
- Ecology Science and Practice; Claude Fourie, Christian Ferra, Paul Medori, Tean Devaux, Oxford and IBH Publishing Co (Pvt) LTD, special Indian edition.
- Principles of Ecology- P.S.Verma, V.K.Agarwal.S.Chand & Company (Pvt) LTD 1989

## Waste Management Lab (BMI049A)

1. Determination of pH of MSW
2. Determination of nutrient value (NPK)
3. Lab scale study on vermin-composting
4. Lab scale study of aerobic and anaerobic digesting of solid wastes.
5. Vermi compositing of organic wastes.
6. Demonstration of Effluent treatment plant.
7. Demonstration of medical waste collection method.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI128A	Environmental Legislation and Policy	4	1	4	2	5

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### Course outcome (CO)

On completion of the course, students are able to:

CO1- Understand the Legal definitions of environmental pollution, natural resource, biodiversity, forest, sustainable development.

CO2- Understand the legal act related to environmental law (British India and Independent India).

CO3- Understand the Indian act relevant to Forest, Wildlife, Water, Air and Motor Vehicle.

CO4- Understand the National Green Tribunal act, scheme and labeling of environment friendly products and Ecomarks.

CO5- Understand the International laws and policy and Case studies in India Stockholm Conference and role of central and state pollution control boards.

#### UNIT I

National Green Tribunal. Legal definitions (environmental pollution, natural resource, biodiversity, forest, sustainable development); Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties).

#### UNIT II

British India: Indian Penal Code 1860, Forest Act 1865, Fisheries Act 1897; Independent India: Van Mahotsava 1950, National Forest Policy 1952, Orissa River pollution and prevention Act 1953.

#### UNIT III

Legislative Instruments The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974; The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Motor Vehicle Act 1988.

#### UNIT IV

The Public Liability Insurance Act 1991; Noise Pollution (Regulation and Control) Rules 2000; The Biological Diversity Act 2002; The Schedule Tribes and other Traditional Dwellers (Recognition of Forests Rights) Act 2006; The National Green Tribunal Act 2010; scheme and labeling of environment friendly products, Ecomarks.

#### UNIT V

International laws and policy and Case studies in India Stockholm Conference 1972; United Nations Conference on Environment and Development 1992; Rio de Janeiro (Rio Declaration, Agenda 21); Convention on Biological Diversity, Montreal Protocol 1987; Kyoto Protocol 1997; Copenhagen and Paris summits. 19 Role of Ministry of Environment, Forests & Climate; role of central and state pollution control boards.

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# MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	0	0	3	0	3	3
CO2	1	1	0	2	2	2	3
CO3	2	0	1	3	1	3	2
CO4	1	0	0	3	1	2	3
CO5	2	1	0	2	0	2	3

3= Highly Related; 2= Medium; 1 = Low

## Suggested Readings:

1. Divan, S. & Rosencranz, A. 2001. Environmental Law and Policy in India. Oxford University Press.
2. Venkat, A. 2011. Environmental Law and Policy. PHI Learning Private Ltd. Reference Books:
3. Abraham, C.M. 1999. Environmental Jurisprudence in India. Kluwer Law International.
4. Agarwal, V.K. 2005. Environmental Laws in India: Challenges for Enforcement. Bulletin of the National Institute of Ecology 15: 227-238.
5. Divan, S. & Rosencranz, A. 2002. Environmental Law and Policy in India: Cases, Materials and Statutes (2nd edition). Oxford University Press.
6. Gupta, K.R. 2006. Environmental Legislation in India. Atlantic Publishers and Distributors.
7. Leelakrishnan, P. 2008. Environmental Law in India (3rd edition). LexisNexis India.
- Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International

## Environmental Legislation and Policy Lab (BMI129A)

1. A case study of any environmental issue relevant to India.

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI130A	Microbial Ecology	4	1	4	2	5

## Course outcome (CO)

On completion of the course, students are able to:

CO 1 Understand the basic concepts within the field of microbial ecology and environmental microbiology.

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CO 2 Understand and Interpret the various ecological and evolutionary principles that impact microbes.

CO 3 Analyze and design experimental approaches used in the field of microbial ecology.

CO 4 Understand functional ubiquity and diversity observed among different microbes.

CO 5 Apply the arguments that researchers in microbial ecology make based on evidence.

### Unit 1

Origin of life: A brief history of the physical origin of the Earth, Chemical and Cellular evolution; Microbial Diversification: Consequences for Earth's Biosphere; Endosymbiotic origin of eukaryotes.

### Unit 2

Microbial Ecology vs. Macroecology, Basic concept of Ecosystem and Biosphere, Concept of habitat and niche, Concept of population growth and community dynamics in microbe, Basic concept of food chain-food web and energy flow.

### Unit 3

Physiological ecology of microorganisms: Adaptation to environmental condition, Abiotic growth limiting factors-Leibig's law of minimum, Shelford law of tolerance. Microbial community succession-biofilm communities.

### Unit 4

Quantitative Ecology: Microbial diversity, OTU, Diversity indices (Shannon, Shimpson), Alpha and beta diversity, Richness and evenness, Samples and samplings, Concept of culturability, Significance of Biogeochemical cycles-Carbon, Nitrogen, Phosphorous, Sulphur.

### Unit 5

Development of microbial communities: r and k strategies. Determination of total and viable microbial number, Molecular analysis of function and diversity of microbial community, Metagenomics and microbiomics

#### Microbial Ecology Lab (BM1131A)

- 1) Types of media – differential, selective, synthetic.
- 2) Isolation and enumeration of microbes from soil sample by serial dilution agar plating method or by viable plate count method.
- 3) Direct microscopic count.
- 4) To obtain axenic culture of microbes by streak, spread, pour plate methods.
- 5) Techniques for preservation of microbial cultures.
- 6) To preserve microbes by freeze drying (lyophilization).
- 7) Carbohydrate estimation by Anthrone method.
- 8) Protein estimation by Lowry's, Bradford and

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Dey  
Rashmi

- 9) To plot bacterial growth curve by spectrophotometer.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES :**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	3	1	1
CO2	2	1	2	1	2	2	1
CO3	3	1	1	2	3	3	2
CO4	2	3	2	2	2	1	3
CO5	2	1	3	1	1	1	1

**Suggested readings:**

1. Environmental Microbiology and Biotechnology by Singh and Dwivedi. New Age Int. Sci. Publication.
2. Environmental Microbiology by Riana.
3. Microbiology by Prescott, Harley and Klein. TMH Publication.
4. Brock Biology of Microorganisms. Prentice Hall Publication.
5. General Microbiology by Stanier. MacMillan Education Ltd.
6. Environmental Microbiology: Principles and Applications. Patrick K. Jjemba.
7. Encyclopedia of Environmental Microbiology, 6 Vol. Set. Willey Publication.
8. Microbial Ecology by Alexander. Willey Publication

Course code	Course Title	L	P	Contact Hr	Contact Hr	Total Credit
BMI132A	Agro-Environment Microbiology	4	1	4	2	5

**Course outcome (CO)**

On completion of the course, students are able to:

- CO 1 Understand the basic concepts of Ethanol fermentation, agro and forest-feedstocks to fermentable sugars, sugars to ethanol.
- CO 2 Understand the alternative ethanol producing organism-Zymomonas mobilis.

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CO 3 Understand the single cell protein, mycoprotein, rDNA technology and its application in Agriculture.

CO 4 Understand the functional of degradation of lignocellulosic waste and biocomposting methods.

CO 5 Understand the biodegradation and biotransformation of Xenobiotics compounds.

### Unit I

Ethanol fermentation, agro and forest-feedstocks to fermentable sugars, sugars to ethanol (yeasts, substrate range, substrate utilization), Ethanol tolerance, flocculation and cell recycle, stillages.

### Unit II

Alternative ethanol producing organism-Zymomonas mobilis (Carbohydrate utilization, ED pathway used by the organism, its tolerance to ethanol); Clostridial fermentations.

### Unit III

Single cell protein, mycoprotein, rDNA technology and its application in Agriculture, Environment and healthcare, GMO's and GEM's- Role of Agrobacterium, Ti Plasmid, transgenic crops, issues related to transgenic organisms,

### Unit IV

Degradation of lignocellulosic waste, Biocomposting-different methods, conditions, different types of compost, conditions for production of compost, Leaching of metal from ores- Bioleaching, organisms involved and their usage.

### Unit V

Biodegradation and biotransformation of Xenobiotics including pesticides, chlorinated and nitrated aromatic compounds, phenolic compounds, polycyclic aromatic compounds.

#### Agro-Environment microbiology Lab (BM1133A)

- 1) Identification of Fungal Contaminants in Plant Tissue
- 2) Identification of Disease Causing Fungal Pathogen of Fruit Plants
- 3) Identification of Pathogens Causing MD-2 Pineapple Fruit Rot
- 4) Microbial Analysis of Food Items
- 5) Bacteriological Examination of Water by Multiple Tube Fermentation Test
- 6) Microbiological Examination of Milk
- 7) Analyze the bacterial colonies in rotten fruit.

**MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:**

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	2	1	2	3	1
CO2	2	2	2	0	3	1	1
CO3	3	3	2	1	1	2	2
CO4	2	1	2	2	2	2	3
CO5	2	1	3	1	1	1	1

**Suggested Readings:**

1. Waste Water Microbiology by Garbiel, Bitton. Wiley Publication.
2. Biopesticides: A Biotechnical Approach by S R Joshi. New Age Publication.
3. Microbial Ecology by Atlas and Bartha.
4. Soil Organic Matter and Biological Activity. Martinus Nigholf W Junk Publisher.
5. Introduction to Environmental Microbiology by Michel Wiley Liss Publication.
6. Advances in Microbial Ecology. K C Marcell, Plenum Press.

**Open elective-I Human Microbial Disease Management (BMI134A)**

Course learning outcomes: By the conclusion of this course, the students

- CO1. Understanding of practical aspects diagnosis of common human infections.  
 CO2. Understanding of preventive measures for human infections by the use of antibiotics and vaccines.

**Unit I**

Human Diseases: Infectious and non-infectious diseases, microbial and nonmicrobial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections Sign and Symptoms of common diseases.

**Unit II**

Microbial diseases: Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent

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outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.

### Unit III

Therapeutics of Microbial diseases: Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides. Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains.

### Unit IV

Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART. Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

### Unit V

Prevention of Microbial Diseases: General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors.

### Reference Books

1. Ananthanarayan R and Paniker CKJ. Textbook of Microbiology. 7th Edition. University Press Publication. (2005).
2. Brooks GF, Carroll KC, Butel JS and Morse SA. Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication. (2007).
3. Goering R, Dockrell H, Zuckerman M and Wakelin D. Mims Medical microbiology. 4th edition. Elsevier. (2007).
4. Drexler M; What You Need to Know About Infectious Disease. National Academies Press (US); 2010.

### Open elective-II Microbial Products (BMI135A)

Course learning outcomes: By the conclusion of this course, the students

CO1. Understanding of practical aspects of production of biofertilizers.

CO2. Understanding of practical aspects of the production of biopesticides/bioinsecticides.



### Unit I

Biofertilizers: General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N<sub>2</sub> fixers: Rhizobium - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis

### Unit II

Cyanobacteria as bio-fertilizers- Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application. Non - Symbiotic Nitrogen Fixers. Free living Azospirillum, Azotobacter free isolation, characteristics, mass inoculums, production and field application

### Unit III

Phosphate Solubilizers : Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application. PGPR - Isolation and Characterization; mass production and application.

### Unit IV

Mycorrhizal Bio-fertilizers: Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

### Unit V

Bioinsecticides : General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, Bacillus thuringiensis, production, Field applications, Viruses - cultivation and field applications.

### Suggested Reading:

1. Atlas RM and Bartha R., Microbial Ecology: Fundamentals & Applications. 4<sup>th</sup> edition, 2000, Benjamin/Cummings Science Publishing, USA.
2. Atlas RM., Microbiology: Fundamentals and Applications. 2<sup>nd</sup> Edition, 1989, MacMillan Publishing Company, New York.
3. Madigan MT, Martinko JM and Parker J., Brock Biology of Microorganisms. 12<sup>th</sup> edition, 2009, Pearson/ Benjamin Cummings.
4. Lynch JM & Hobbie JE., Microorganisms in Action: Concepts & Application in Microbial Ecology, 1988, Blackwell Scientific Publication, U.K.
5. Maier RM, Pepper IL and Gerba CP., Environmental Microbiology. 2<sup>nd</sup> edition, 2009, Academic Press.
6. Eugene L. Madsen. Environmental Microbiology: From Genomes to Biogeochemistry. 1 Edition, Wiley Blackwell Publishing. (2008).
7. Agrios, G.N. Plant pathology. Harcourt Asia Pvt. Ltd. (2000).

S. Buchanan, B.B., Grussem, W. and Jones, R.L. Biochemistry and Molecular Biology of Plants.  
I.K. International Pvt.Ltd. (2000).

### Open Elective-III Biosafety and IPR (BMI136A)

#### Course outcome (CO)

On completion of the course, students are able to:

CO1 Analyze and understand the working in a microbiology laboratory taking all safety measures, handling of live bacteria, disposal of infectious waste, care of the equipment requiring safety audit

CO2- Understand the knowledge of basic concepts related to IPR.

CO3-Understand and apply knowledge of patent filing, and some well-known/well-publicized case studies related to IPR

CO4 -Understand and apply grant of patent and patenting authorities

CO5-Understand the agreements and Treaties

#### Unit I

Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms  
AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

#### Unit II

Biosafety Guidelines: Biosafety guidelines and regulations(National and International):  
GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC).  
RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of  
GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of  
International Agreements - Cartagena Protocol.

#### Unit III

Introduction to Intellectual Property: Patents, Types, Trademarks, Copyright & Related Rights,  
Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of  
IPR – patentable and non patentables – patenting life – legal protection of biotechnological  
inventions – World Intellectual Property Rights Organization (WIPO)

#### Unit IV

Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT,  
Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures;  
Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies,  
Rights and Duties of patent owner.

## Unit V

Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

### Suggested Readings

1. Private Power, Public Law: The Globalization of Intellectual Property Rights By Susan K. Sell Cambridge University Press, 2000
2. Essentials of Intellectual Property: Law, Economics, and Strategy By Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition )
3. M K Sateesh .Bioethics and Biosafety . Kindle Edition
4. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006
5. Shomini Parashar, Deepa Goel, IPR, Biosafety and Bioethics Pearson India 2013

*Handwritten signatures:*  
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